POWER PLANT ENGINEERING

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Boiler Furnaces for Gas, Oil and Pulverized Coal

THE PLANT OF MORRIS & CO. AT OKLAHOMA CITY HAS THREE COMPLETE FUEL BURNING INSTALLATIONS, EACH ADDED AS NECESSITY DEMANDED AND RESULTING IN A FURNACE CAPABLE OF BURNING EITHER GAS, FUEL OIL OR PULVERIZED COAL AT HIGH EFFICIENCY

MORRIS & CO. has a unique fuel burning equipment in its packing plant at Oklahoma City, Oklahoma, which places the company in a commanding position as regards the fuel question. Through the courtesy of W. O. Heitner, mechanical engineer of the company, a description of this installation is available.

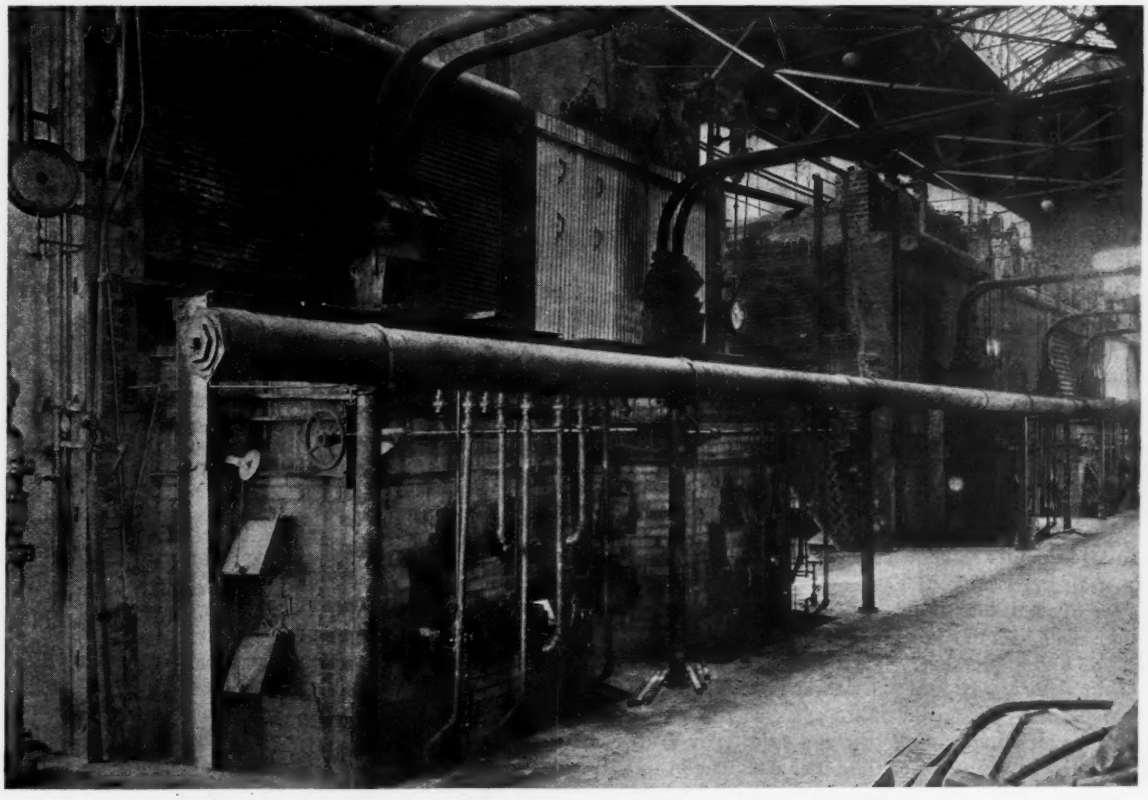

FIG. 1. VIEW OF THE BOILER ROOM OF THE MORRIS & CO. PLANT AT OKLAHOMA CITY SHOWING INSTALLATION OF GAS, OIL, AND PULVERIZED COAL BURNING EQUIPMENT

This company has met the fuel situation at this particular plant in a most comprehensive manner. Coal shortage and railroad strikes hold no particular terrors for them. Their plant is equipped to burn at a moment's notice either coal, oil or gas. Each one of the five 500 and two 300-hp. water-tube boilers is provided with pulverized coal, gas and oil burners so that an almost instantaneous change can be made from one fuel to either one of the others.

The combustion space is large enough to permit the boilers to steam at 150 per cent rating with a normal rating of 2 cu. ft. of furnace per boiler hp. developed. From the bottom of the ash pit to the first pass is about 15 ft., the distance from the firing doors to the bridge wall is

11 ft. 6 in. and the width at the bridge wall is 10 ft. 9 in., while at the firing doors it is 4 ft. 9 in. The total volume approximates 1500 cu. ft.

The volume of the furnaces on the 300-hp. boilers is practically the same as that on the 500 so that these two boilers can be run at a much higher rating, 250 per cent, without crowding.

The area of the gas passage at the entrance of the first pass is 5100 sq. in. from which it gradually diminishes to 2950 sq. in. in the third pass and to 2750 sq. in. in the up-take.

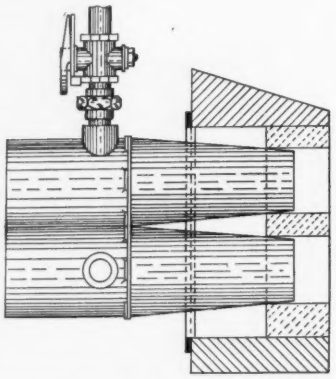

FIG. 2. A BATTERY OF GAS BURNERS AS INSERTED IN THE FIRING DOOR

The firing floor is about two-thirds of the height of the combustion chamber from the ash pit floor. There are 12 ports, nine above and three below this floor, in the front wall, fitted with flap valves, through which secondary air for combustion is admitted. These ducts also serve as openings in which the gas and oil burners are fitted.

As this plant is adjacent to the gas fields of Oklahoma, it was originally designed to use natural gas. The gas is piped from the field at about 2 lb. pressure and is delivered to a 10-in. distributing header at 8 oz. pressure through a reducing valve. It is metered just after it passes the reducing valve by a calibrated pitot tube. The average consumption of the gas at its present quality, at standard conditions (14.7 lb. abs. pressure and 62 deg. F.) is about one and one-half million cu. ft. per day.

Leads to the burners are tapped into this 10-in. distributing header that runs along the front of the boilers at suitable points as shown in Fig. 1. The burner consists of an inner and outer casing and a nozzle. A large number of small brass studs are driven through the inner casing. The annular space between the casings is filled with gas under pressure. Holes are drilled through the studs in such a way that the gas is introduced into the inner space in a number of fine jets so directed as to produce a swirling motion in the nozzle. Air is drawn in through the open end of the inner chamber in quantities sufficient to support combustion. These burners are inserted, four in a group, in the air ports, as illustrated in Fig. 2.

The gas is somewhat leaner now than it has been, the heating value averaging about 875 B.t.u. per cu. ft. The efficiency of this setting averages around 78 per cent.

The labor charges are low for this installation as the fuel does not have to be handled and because there is no ash to be disposed of, and as there are no banking periods, standby losses are reduced to a minimum.

The oil burning equipment was installed later on when the quality of the gas began to fall off. Under average load conditions, this plant burns about 540 bbl. of oil per day or about 2½ carloads. The oil is unloaded from the cars into two concrete tanks located in a far corner of the company's premises. These tanks which have a total capacity sufficient for eight days' supply are built entirely above ground. Steam coils are provided on the bottom of each tank to heat the oil sufficiently to permit its being pumped a distance of about 1000 ft. to the boiler room. At the boiler room it is metered through a disk meter and then pumped up to feed pressure, 60 lb. per sq. in., and heated to feed temperature, 160 deg. F., in a unit installation of pump and heater. The heating is done by the exhaust steam from the pumps. A header under the firing floor distributes the oil to the two burners in each furnace through two leads. The burners are inserted into the furnace through two of the previously mentioned ports immediately above the firing floor.

The burner employed as shown in Fig. 3 is a modification of the drolling type. It is composed of two chambers one above the other, the upper one being for oil and the lower one for steam. The oil is forced through perforations in the metal connecting the two chambers near the nozzle. The steam passing this perforated plate sweeps the oil off and sprays it fan shaped in an atomized condition out into the furnace, through a suitably shaped lip. The spray is directed slightly upwards and against the bridge wall. The air necessary for combustion is admitted through the ports.

The oil used runs about 24 deg. Baumé with an average heating value of about 19,500 B.t.u. per lb. The efficiency burning oil is practically the same as that with gas, about 78 to 79 per cent. Here, as with gas fuel, labor charges for fuel handling are low as are also the standby losses.

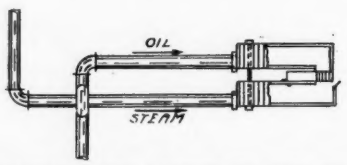

FIG. 3. DIAGRAMMATIC LAYOUT OF THE OIL BURNER EMPLOYED

As the flame from both the gas and oil burners is in the same direction, these fuels may be burned together with entirely satisfactory results and with an efficiency comparable with that obtained with either one separately.

Figure 4 shows a section of the boiler and setting with pulverized coal, fuel oil and gas burners installed, and emphasizes the large combustion space.

When the cost of oil began to climb, they looked to coal to furnish their power and installed a pulverized coal burning equipment. Owing to the location of the plant, the McAlister coals are used to a great extent, although Texas lignites have been used with good econ-

omy. Even though the freight on the Texas fuel is much greater, the cost f.o.b. plant is less per B.t.u. even considering the extra volume to be handled and the extra ash to be disposed of. The McAlister coal averages about 10,500 B.t.u. per lb. while the lignite runs around 7000.

The coal is passed from the storage bunkers through a crusher to the dryer, which is an indirect fired rotary kiln. A low-temperature fire is maintained to prevent the ignition of the coal being dried and the distillation of the volatile combustibles. Here the moisture content is reduced from about 4 per cent to from 1 to 2 per cent in the case of the McAlister coal. From the dryer the coal passes over a magnetic separator, to remove any iron scraps that might be present, and into the pulverizing mill. Here it is reduced to a fineness such that 95 per cent will pass a 100-mesh and 85 per cent a 200-mesh screen. From the pulverizer, the coal is carried by a screw conveyor to the pulverized coal hopper, adjacent to the boiler room. From the bottom of this hopper it is fed by another screw which is capable of being run at variable speeds into the burning pipe. Here it is intimately mixed by a paddle wheel with the air that conveys it to the burner, Fig. 5. This air is supplied by a variable speed blower and amounts to approximately 10 per cent of the air required for combustion. Another 25 per cent of the air requirements is introduced at the burner, Fig. 6. The remainder

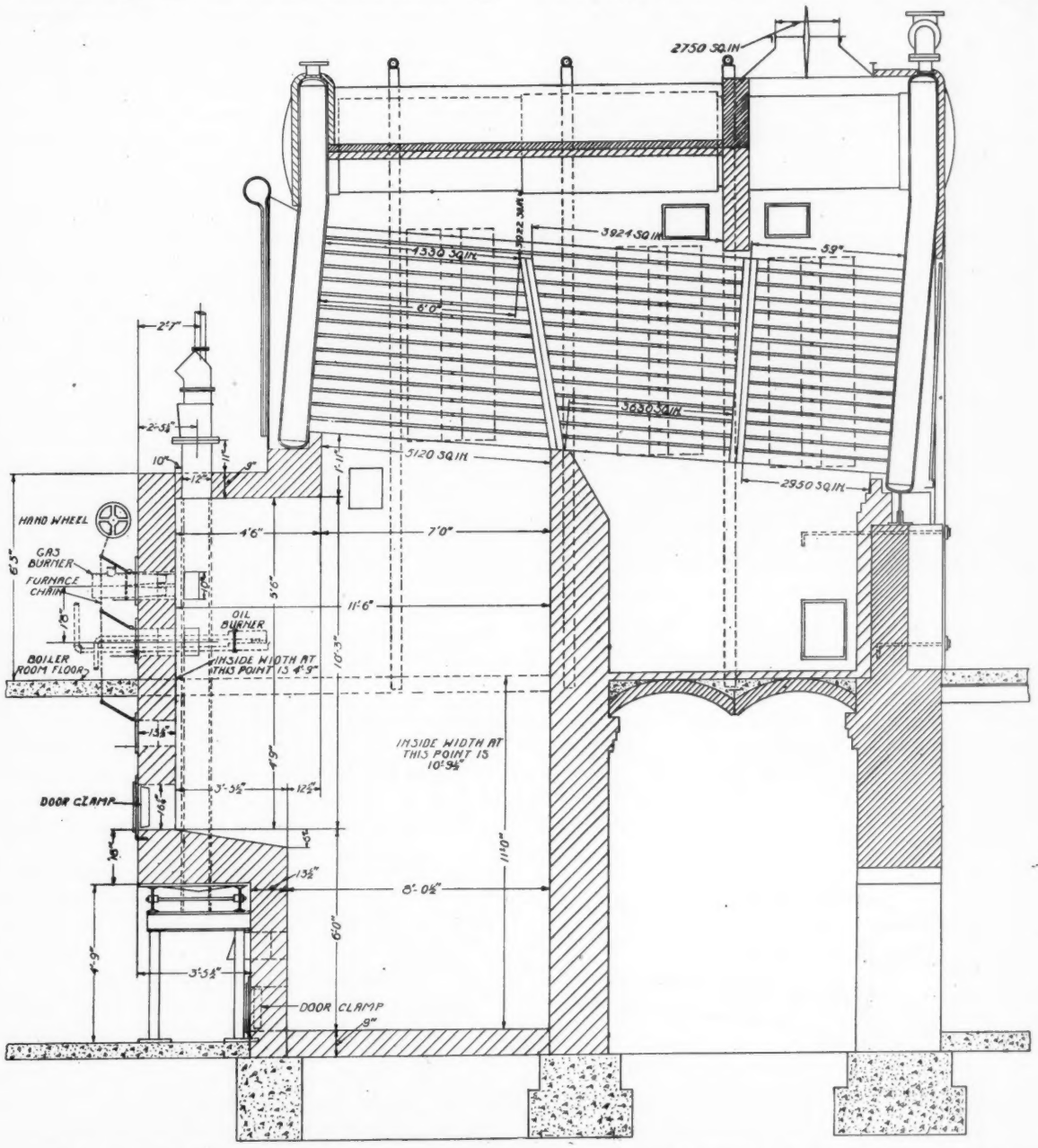

FIG. 4. SECTION OF THE FURNACE SHOWING INSTALLATION OF PULVERIZED COAL, FUEL OIL AND GAS BURNERS

is drawn in through the ports in the front of the furnace. As will be seen from Fig. 4, the burner directs the flame down along the front wall of the furnace; it impinges on a ledge near the bottom of the combustion space and is deflected upward toward the first pass. This increases the length of travel and insures completion of

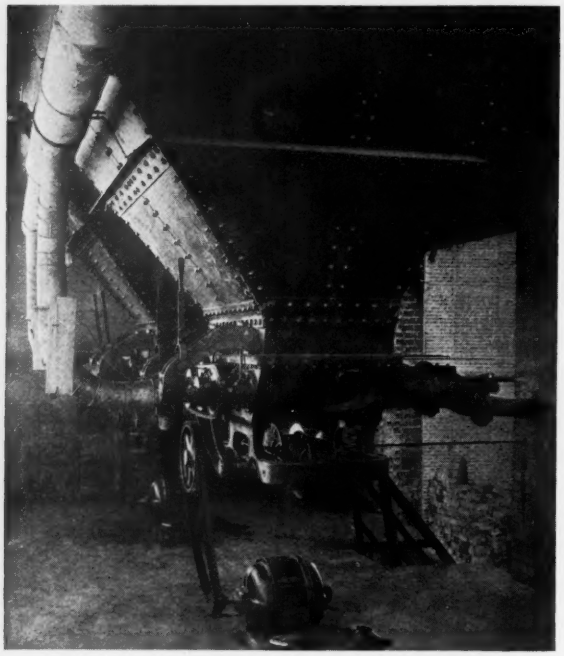

FIG. 5. PULVERIZED COAL FEEDING APPARATUS

the combustion before the gases reach the tubes. As the flame from burner scrubs along the front wall of the furnace, the abrasion here is rather high and the brick work has had to be renewed frequently. The flame impinging on the ledge deposits slag which gradually builds up and has to be removed once in a while.

As there is a considerable amount of tube surface exposed to radiation, the furnace temperature is kept at about 1900 deg. The flue gas temperature in the breeching averages 500 to 525 deg.

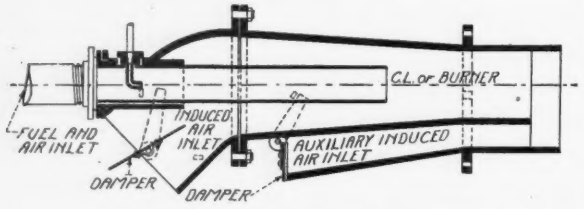

FIG. 6. PULVERIZED COAL BURNER

Of the ash that is formed, about one third is collected from the bottom of the furnace, one third is removed from between the second and third passes, and the other third leaves the setting. It is a question as to how much actually leaves the stack, but whatever it is, it is not noticeable in the environs of the plant.

The quantities of fuel and air admitted can be controlled separately and to a nicety. Flue gas analyses showing 15 per cent CO_2 indicate excess air to the extent of approximately only 10 per cent. Efficiencies of 83 per cent have been recorded on tests.

It will be noted that the efficiency indicated is higher than that obtained with either gas or oil fuel. This can probably be explained by the fact that there is much more water formed in the combustion of the gas and oil due to the high hydrogen content. This water has to be evaporated by heat that could otherwise be absorbed by the boiler.

On account of the location of the pulverized fuel burner, oil cannot be burned with the coal as the oil burner would be directly in the path of the coal flame. It is, however, a simple matter, and one that requires little time, to install either the gas or oil burners when a curtailment of the coal supply would make this necessary.

Gasoline and Crude Oil

By J. B. Dillon

THE Independent Oil Dealers Association were holdin a convention in Denver, Colorado.

Opinions were freely expressed by many that gasoline and crude oil will advance in price due to the increased consumption which will naturally follow the action of automobile manufacturers reducing the price of cars. The consensus of opinion was that none need fear the supply of gasoline will be exhausted for many years to come, although local shortages may present themselves, due to wells in the vicinity becoming dry.

It was also proclaimed that in Pennsylvania producers have taken over wells that long since were abandoned, and that the use of new and improved machinery and methods has been instrumental in bringing forth gasoline and crude oil from what, for years, was believed to be dry sand.

To know that sanguineness prevailed, we have only to listen to the words of a few of the optimists present, and whose utterances seemed to get a universal Amen.

"Why worry. If the visible supply becomes scarce, somebody will find a substitute, or some new manner of producing the old stuff, from sources we never thought of."

Personally, I love to hear such sentiments; but from the moment I was old enough to realize, I have always been a strong opponent against wasting anything because I believe that sentence which I read in my school grammar, "Wilful waste makes woeful want."

Imports of Coal Into France

Official statistics of the importation of coal into France during the first seven months of 1920, as given in The Review of the American Chamber of Commerce in France, show a total of 13,700,079 tons. The total imports of coke were about 2,370,000 tons. The figures for the coal by countries of origin are as follows:

From	Tons
Sarre	2,581,819
Great Britain	7,771,338
Belgium	686,554
United States	612,919
Germany	1,990,255
Other countries	57,194
Total	13,700,079

Power Development in New World and Asia

South America, an Attractive Field for Capital and Professional Engineers. By L. W. Alwyn-Schmidt

POWER development in countries outside Europe, with the exception always of the United States, has been held back somewhat by the war. It is, however, unnecessary to speculate about the probable progress of the industry had war not interfered, in view of the fact that the power industry outside Europe has been extremely active during the last 2 yr., with projects under way which exceed in daring and utility practically everything that has been attempted in the past. The power engineer works in these so-called new countries always upon virgin soil. This is an enormous advantage, because there exist no vested interests that have to be compensated. Steam power generation has not found that hold upon the various markets as it has in the old world and there is no steam power equipment that stands in the way of applying electrical power; but against this, there is the effect of larger distances, sparsely populated districts and higher cost of construction which prove a serious impediment in the way of the constructing engineers. Also economic conditions have to be considered. Steam power has to be applied in conjunction with water power, not only for the operation of the electrical central stations but also in supplying power to individual factories. The problem of bringing about a perfect economic balance between all the factors of power production is still not completely solved and engineers are inclined to advance rather carefully, knowing the responsibility which rests upon their shoulders. Central power development, however, having once found its proper footing, is progressing more and more rapidly.

Canada, our northern neighbor, owns today a primary power machine development in central electric stations amounting to 2,137,743 hp., $356,547,217 being invested in power equipment and transmission and distributing systems. Following the economic tendency of the western world, 71.7 per cent of this is invested in privately controlled central stations while the rest is under municipal or public ownership; approximately 90 per cent of the total investment has been expended upon hydroelectric stations; 1,836,618 hp. are produced by water power, 288,202 hp. by steam and 12,923 hp. by internal combustion engines. The total water power development of Canada, including direct application of water power, amounts to 2,418,000 hp.

South American Power Industry Prosperous

Of more interest to our power engineers possibly than Canada, is South America at the present time. The American power industry has taken over several large concessions in South America and the increasing influx of North American capital into South American industrial enterprises gives a new impetus to American power development in South America. Owing to the comparative inactivity of our banks in South America before the war, the American investor has still not learned to take a full interest in South American financial affairs. Large opportunities have been let slip and only quite recently American financiers have seen the great investment possibilities offered by our southern neighbors. This has given a large lead to other nations that have made good use of it and many of the best railroad and mining concessions have gone to European investors. Conditions in the power industry differ slightly. Large power development is still new in South America and investors and engineers coming today to South America find the field still only sparsely occupied. There are a number of large prospects that wait for an energetic syndicate that will take them in hand and there are also a great many smaller opportunities that might appeal to the individual engineer with a small group of investors backing him. There are, in fact, possibilities in South America for power stations that might appeal to any engineer having a little capital to undertake as a private enterprise. Local capital can also be obtained now more easily than was the case before the war. Practically each city of limited size offers a market for a small power station, supplying light and power and operating possibly in addition a small local railroad.

A comparatively new field in this respect is Bolivia, where mining and other industries are now springing up in quick succession and where American capital has started to assist local investors. But while the unworked field promises the larger return in the long run, it is, nevertheless, the country that has already passed the early stages in industrial development that offers the greatest security. Argentine, Brazil, Chile and Peru, therefore, are pronounced by experts to be the most promising markets for new power development, and those where the American engineer would find most encouragement. In all these countries, in fact all over South America, the power problem is closely connected with the fuel problem. Coal is available only in insufficient quantities in most South American countries. Coal and other fuels, therefore, have to be imported in large quantities.

Argentine, for instance, has to import 4,000,000 tons of coal annually to serve its industries with power. The solution of the power supply problem of Argentine, therefore, is equivalent to the finding of a method that will give the maximum of power production with the minimum of fuel consumption. At the present time, the Argentine industry requires nearly 700,000 hp. for its operation and it is generally held that it could make use of double that number if only it could be supplied more easily. As it is, the industrial development of a large country is deliberately held back by its lack of power and fuel. Improved methods of firing and power transmission, saving power and fuel, therefore, are needed in Argentine, and the question has been discussed: How far will it be possible to use some of the low quality coal found in Argentine for the generation of electrical power to be transmitted to the consuming centers? The coal fields of Argentine are placed nearly all on the western border of Argentine. They are difficult to reach and, therefore, cannot be worked easily. It is also very doubtful whether the production and transportation of that coal over long distances to the Eastern coast would be a paying proposition. Central stations erected in these

fields, however, might be able to transmit the power much more cheaply than the coal could be transported. So far no private capital could be found to develop the coal fields and the government also has found their use impracticable. Some of the coal has been found to be rather good gas coal, and if converted into gas and used in this form for the working of electrical power stations, it might form a very important factor in the future power development of Argentine. A special reason why the development of these coal fields has not appealed until now to the Argentine nation is that it has been attracted more by the possibilities of exploiting its water power resources which appeared to be a better means of relieving the fuel shortage. The trouble with these water powers is that they are found in a comparatively limited territory and in some cases are just as far removed from the points of power consumption as the coal fields. If it should be, however, a matter of transmitting power over long distances, this might be done more profitably with power generated by water than with that generated by coal. Engineers say that the falls of the Iguaza River offer the best opportunity for producing hydroelectric power in Argentine. These falls are situated on the border of Brazil and Argentine 12 mi. above the junction of the Iguaza with the Parana. The falls have been compared in power and scenic beauty with those of the Niagara. But the distance between Buenos Aires and these falls amounts to 700 mi. approximately. American, French, and engineers of other nations, have nibbled already on this project without having taken the decisive step. Now the Argentine Government has taken the matter in hand and will spend a certain amount of money for having an independent survey made, which probably will lead to the designing of plans for a development; 300,000 hp. are to be drawn from this source.

Another important center of power development is found in Northern Patagonia, just as far removed from Buenos Aires as the first named source, but offering enormous possibilities as the water powers obtainable in this area are estimated very conservatively at 2,000,000 hp. Although in this manner the available water powers in Argentine are very large, little has been done to develop them, and today there is in operation only one hydroelectrical plant with another one in building. The first-named enterprise is operated by an English company and produces 4500 hp. The other is a subsidiary company of the German company operating a number of electrical enterprises in South America.

Adding to Power Supply Without Increasing Coal Consumption

What applies to Argentine applies in just the same manner to its sister republics in South America. In each case, there is the desire to improve upon the power supply by cutting down fuel consumption. Brazil has taken steps to develop various new sites and the electrification of some of the Brazilian railroads, now definitively decided upon, is bringing about a rearrangement of power consumption which will no doubt aid largely in the preservation of primary fuel. More recent power development in Chile has been closely connected with the growth of the Chilean mining industry, which was possibly one of the most outstanding features of the economic life of the republic during the war. American capital has found its entry into Chile on a very considerable scale and has worked a revolution in mining method and practice in Chile. As an example may be quoted the large mines of Chuquicamata with its large mining camp housing 10,000 men in a city of nearly 2000 houses. Water to this camp is brought a distance of 90 mi. approximately, but the city is one of the finest camps that may be imagined, with club houses, churches, a swimming pool, a large theater, a racing course, tennis courts, football fields, and the most modern sanitation. The works of the mines and the city are supplied by an electrical central station. Similar enterprises are found all over Chile and they have provided a power problem of their own. It would be impossible to supply these mines from centrally placed power stations, transmitting power to a great number of enterprises, principally because the mines are placed widely apart and also because there are very few power sites in the Chilean mining district. Individual power plants, operated by Diesel engines, therefore, are preferable for mining work and large central stations have an opportunity for development only in the large cities. In the south of Chile there are plenty of smaller water sites that might be developed with advantage to be used for supplying power to farms and small settlements, which are very numerous in that part of Chile. The north, however, is poor on water, the mines have to carry it over long distances and can, of course, not make any use of it for power generation.

England Prepares Large Developments in India

In Asia, British India seems to stand at the present time in the center of power development. The British Government has given the irrigation of India great attention during the period before the war and incidentally has made use of the water works to drive large power stations which are now supplying extended sections of India with water. During the war, this progress has not been so fast, although various stations have been completed and others extended. With the return of peace, means, however, have been made available and a number of projects have been taken in hand. Seven larger and smaller enterprises are reported from Southern India alone. Several of these are of minor character only and will be operated by private capital, but governmental assistance will be given also to some. In the Mysore State, where large gold fields have supplied a regular demand for power, there exists a large hydroelectric plant at Sivasamudram; 25,000 hp. are available from the waters stored by aid of the Krishnarajasagara dam, of which 22,500 hp. are utilized already; it is now contemplated to produce another 8000 hp. from the waters of the same water-shed; all in all, 100,000 hp. seems to be available in that region.

The demand for electrical power has grown very rapidly all over India, where industrial activity has been very great during the war. Nearly all cities have witnessed an enormous addition to their load for power and electric light and the very far carrying industrial development schemes of the British government will provide for a continually rising demand for industrial purposes. The English government is foreseeing this development and has made arrangements to supply all India with electrical power which will be drawn partly from water sources or will have to be generated by

steam. The whole country has been surveyed and additional surveys are made continually. Naturally the enormous size of the empire makes imperative sectional development in the beginning and no comprehensive scheme can be executed at the present time. In future the various enterprises, however, will be linked up and an attempt has been made already in respect to the Mysore scheme mentioned above.

The Island of Ceylon, known for its tea and rubber, will soon have a large centrally located power station which will aid in the electrification of the island's industries and railroads. The undertaking, most likely, will be carried out by the island government, and it is expected that most of the orders for equipment will be placed in England.

The Japanese government contemplates the erection of a large hydroelectric power plant on the River Shinanogawa near Tokyo, to be supplemented by a steam power plant for the purpose of executing the complete electrification of all Japanese railroads; 100,000,000 yen will be required to carry out this project, 50,000,000 of which are to be subscribed by the government, the rest to be offered to Japanese investors. The necessary bill for this purpose has been introduced already in the diet and if it is passed, Japan will be the first country in the world having a complete electrical railroad system.

The New Zealand government, which is possibly the most progressive of the governments of the world, as far as electrical power development is concerned, has appropriated $21,000,000 for the building of a large power station at Arapuni, which is 126 mi. south of Auckland and is expected to develop 160,000 hp. The dam required for this plant will be 15 ft. at the top, 48 ft. at the base and 160 ft. high. A lake will be formed 18½ mi. long. The government has also taken over a large power plant near Cambridge known as the Horahora plant which is to supply electrical power to the Waikato dairying district; 1000 milking plants, six dried milk factories, and 20 cheese and butter factories, will be supplied with power from that source. In the South Island, a large power station is contemplated on the Lake Monowai, $4,800,000 having been voted for its construction.

Loss Through Pipe Line Fittings*

METHOD FOR MAKING ALLOWANCE FOR RESISTANCE TO FLOW OF FLUIDS DUE TO FITTINGS IN PIPE LINES. BY DEAN E. FOSTER

IN the layout of piping in power plants, heating systems, refineries and other projects, the engineer is frequently confronted with the problem of making proper allowance for the resistance offered by fittings to the flow of liquids and gases. Konrad Meier, in his excellent treatise entitled The Mechanics of Heating and Ventilation, has given the subject of the effect of fittings on resistance to flow a very careful study and has presented data thereon in the form of seven charts, the only objection being the time required to analyze them. After some study of the equations used in their construction, however, it was found to be a comparatively easy matter to formulate the following relations between the frictional resistance of pipes of various sizes and the various screwed fittings commonly used, and from these relations to establish tables showing the lengths of pipe equivalent in resistance to that offered by fittings.

WATER FLOW

FOR THE FLOW of water through pipe lines, Mr. Meier uses the formula

$$H_f = 0.0257 \times v^{1.86} \times L \div (2gd^{1.25})$$

where H_f = loss of pressure in ft., v = velocity in ft. per sec., d = diameter in in., L = length in ft.

For resistance offered to flow by fittings, Mr. Meier gives the following:

$$H_r = 1.38r \times v^{1.86} \div 2g$$

where H_r = ft. of pressure loss per fitting, r = a factor of resistance whose value depends upon the shape of the fitting, v = velocity of the fluid in ft. per sec.

By combining these equations, we obtain

$$L_e = 53.75r \times d^{1.25}$$

where L_e represents the number of feet of pipe equivalent in resistance to a fitting and the other factors as before. Table I has been made up from this equation and may be used for water, crude or refined petroleum oils of 32 deg. B. gravity or lighter, or other non-viscous liquids.

STEAM FLOW

FOR THE flow of high-pressure steam through pipes Mr. Meier uses the equation:

$$P_f = W \times 0.0257 \times v^{1.93} \times L \div (288gd^{1.2})$$

where P_f = pressure in lb. per sq. in. to overcome frictional loss.

For resistance offered to flow by fittings, he gives

$$P_r = W \times 1.12R \times v^{1.93} \div 288g$$

By combining equations we obtain

$$L_e = 43.7rd^{1.2}$$

There is no reason to assume that the flow of gas or air through fittings should occasion losses differing from those caused by the flow of steam. Hence the writer assumes that the equivalents of Table II may be used for all three fluids.

Many charts and diagrams for the quick determination of steam-pipe sizes have been published, but they have all been constructed under the assumption that dry saturated steam was the fluid to be carried. The accompanying chart, Fig. 1, however, solves problems involving the carrying of either dry saturated or superheated steam. In order that its use may be clear, the following case has been assumed, the pressure loss in lb. per sq. in. per hundred feet being desired.

Average steam pressure in line.....140 lb. abs.
Superheat .....150 deg.
Amount of steam to be delivered.....1700 lb. per min.
Size of pipe.....10 in. standard

In the solution shown in Fig. 1, the chart is entered on the horizontal line representing 150 deg. of superheat. This line is followed to the left until it intersects the curve representing 140 lb. pressure. From this intersection, the dashed vertical line is followed down to its intersection with the horizontal dashed line representing 1700 lb. of steam. From this intersection, the inclined

* From a paper before the A. S. M. E., December, 1920.

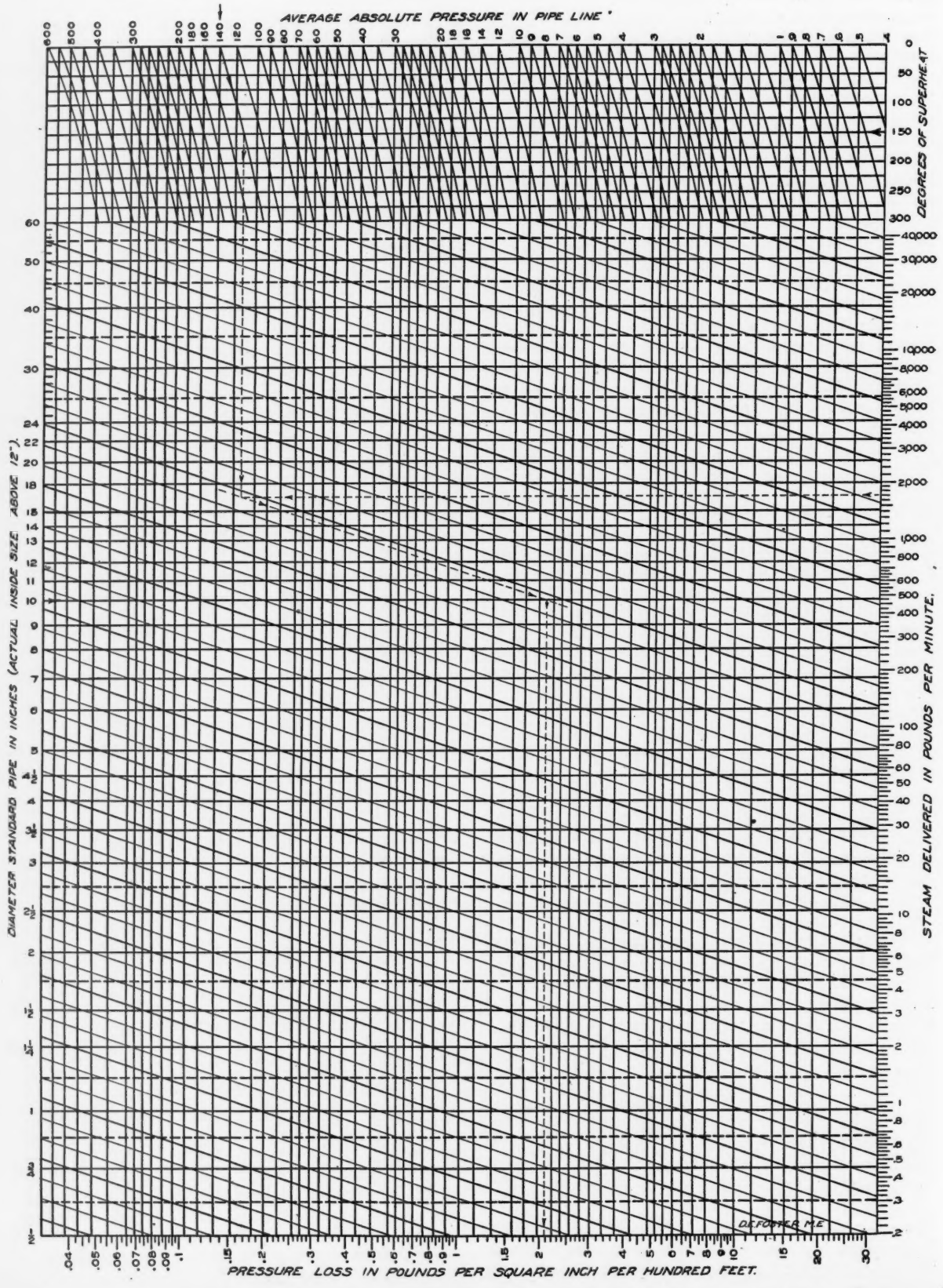
AVERAGE ABSOLUTE PRESSURE IN PIPE LINE
DEGREES OF SUPERHEAT
DIAMETER STANDARD PIPE IN INCHES (ACTUAL INSIDE SIZE ABOVE 12")
STEAM DELIVERED IN POUNDS PER MINUTE.
PRESSURE LOSS IN POUNDS PER SQUARE INCH PER HUNDRED FEET.
DEFOREST PE

FIG. 1. GRAPHICAL METHOD (BABCOCK'S FORMULA) FOR FLOW OF STEAM IN PIPE LINES

dashed line is followed to its intersection with the horizontal line representing 10-in. pipe. The vertical thus determined, followed down to the bottom scale, gives the loss required as 2.08 lb. per 100 ft. Had a 12-in. pipe line been used, the loss would have been only 0.81 lb.

Figure 1 can be used for the solution of any case where four of the variables are known and the fifth is to be determined. For the solution of problems involving dry saturated steam, enter the chart at the top at the point representing the pressure assumed and follow a vertical line from this point to its intersection with a horizontal representing the desired quantity of steam. The remainder of the solution will be the same as outlined for superheated steam.

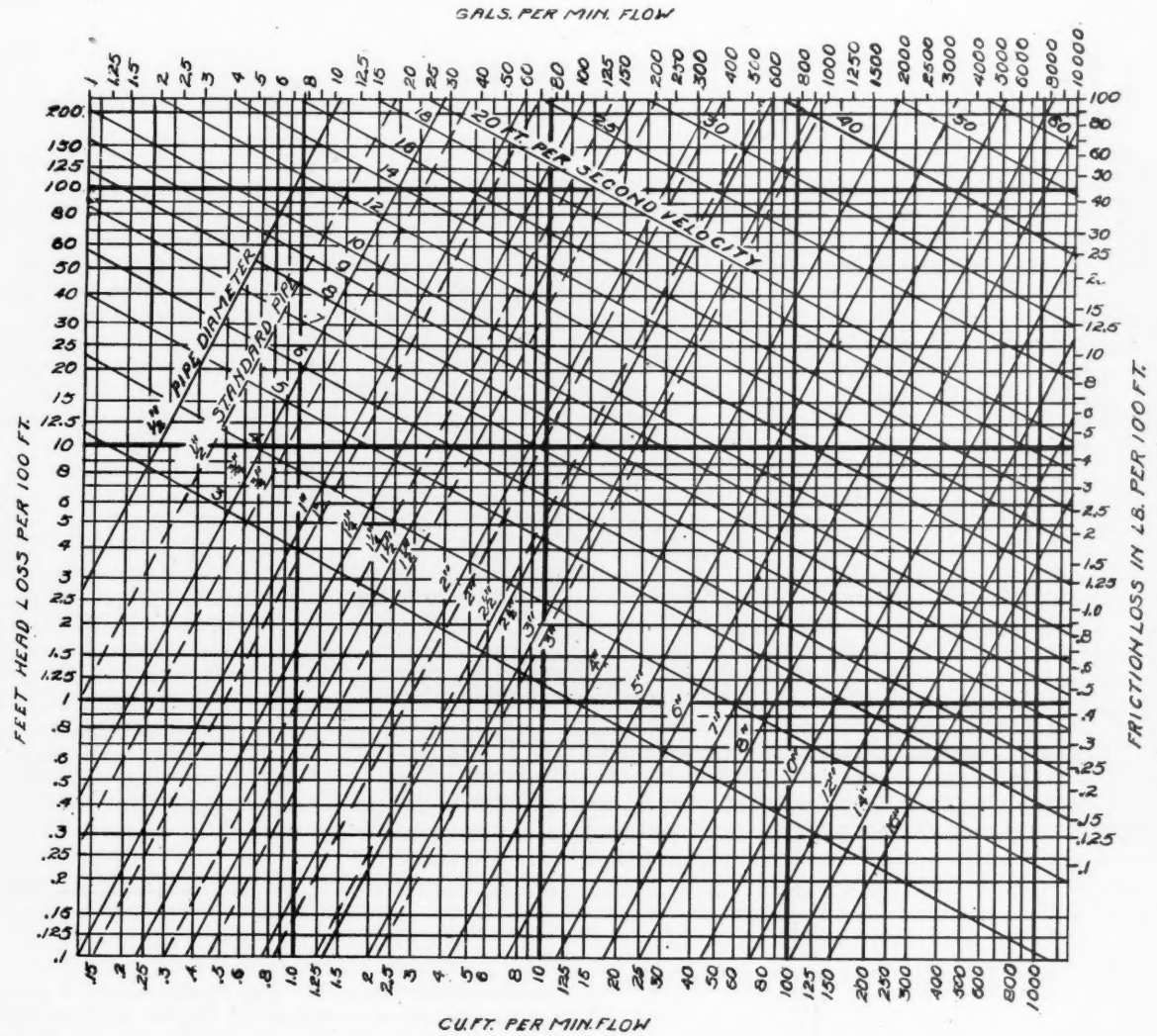
GALS. PER MIN. FLOW
CU.FT. PER MIN. FLOW
FEET HEAD LOSS PER 100 FT.
FRICTION LOSS IN LB. PER 100 FT.
PIPE DIAMETER
STANDARD PIPE
20 FT. PER SECOND VELOCITY

FIG. 2. GRAPHICAL METHOD (W. R. CLARK) FOR FLOW OF WATER IN PIPE LINES. DOTTED DIAGONALS ARE FOR STANDARD PIPE. FULL LINE DIAGONALS FOR ACTUAL INTERNAL DIAMETER SHOWN

Steam Line Calculation

To show the use of Table II, an example has been taken of a 6-in. steam line 1000 ft. long, containing 5 gate valves, 3 angle valves, 20 standard tees and 10 standard ells. From Table II for steam, air and gas, these fittings are found to be equivalent to 332.10 ft. of 5-in. pipe as follows:

5 Gate valves, each 4.81	24.05
3 Angle valves, each 17.35	52.05
20 Standard tees on run, each 6.35	127.00
10 Standard ells, each 12.90	129.00
Total allowance	332.10 ft.
Actual pipe length	1000.00
Equivalent total length	1332.10 ft.

The chart shows that with an initial pressure of 150 lb. and a total loss of 5 lb. pressure or 0.375 lb. per 100 ft. this line will transmit about 225 lb. of steam per min. If the effect of the valves and fittings had been ignored, the calculations would show a capacity of 260 lb. of steam per min. This would have indicated a flow of 11½ per cent more than the real capacity of the line. This error in capacity will be the same no matter what pressure drop is allowed through the line.

Water Line Calculation

Use of Table I is illustrated by the solution of the following problem which assumes that a 4-in. line is to handle 26.2 cu. ft. of water per min. through a horizontal run of 50 ft., at which point the line rises at right angles 35 ft., thence runs horizontally 120 ft. to a tee heading a manifold consisting of five pieces of 4-in. pipe 12 ft. long connected by 4-in. tees, each delivering 1/6 of the total quantity of water. A centrifugal pump is to be selected and properly speeded to handle this quantity of water. The pump is to be located 10 ft. above the water surface.

TABLE I. FEET OF STANDARD PIPE EQUIVALENT TO SCREWED FITTINGS FOR LINES CARRYING NON-VISCOUS LIQUIDS

Nominal Pipe Size, in.	Actual Inside Diameter, in.	Gate Valve	Long-Sweep Elbow or on Run of Standard Tee	Medium-Sweep Elbow or on Run of Tee Reduced in Size 1/4	Standard Elbow or on Run of Tee Reduced in Size 1/2	Angle Valve	Close Return Bend	Tee through Side Outlet	Globe Valve
Factor of Resistance		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
1/2	0.662	0.335	0.442	0.56	0.89	1.20	1.34	1.79	2.68
3/4	0.824	0.475	0.627	0.79	1.27	1.71	1.90	2.52	3.80
1	1.049	0.640	0.844	1.07	1.72	2.30	2.56	3.40	5.12
1 1/4	1.38	0.902	1.19	1.51	2.42	3.24	3.61	4.80	7.22
1 1/2	1.61	1.09	1.43	1.83	2.92	3.92	4.36	5.79	8.72
2	2.06	1.49	1.96	2.50	3.99	5.36	5.96	7.92	11.92
2 1/2	2.46	1.86	2.46	3.13	5.00	6.72	7.47	9.93	14.94
3	3.06	2.46	3.25	4.11	6.66	8.87	9.86	13.11	19.72
3 1/2	3.54	2.92	3.80	4.91	7.84	10.53	11.70	15.56	23.40
4	4.026	3.44	4.53	5.77	9.22	12.37	13.70	18.28	27.50
4 1/2	4.506	3.95	5.20	6.63	10.60	14.22	15.80	21.01	31.60
5	5.047	4.57	6.00	7.68	12.20	16.47	18.30	24.33	36.60
6	6.065	5.72	7.55	9.61	15.30	20.61	22.90	30.45	45.80
7	7.024	6.90	9.10	11.59	18.50	24.84	27.60	36.70	55.20
8	7.981	8.10	10.69	13.60	21.70	29.16	32.40	43.05	64.80
10	10.020	10.70	14.10	17.97	28.70	38.52	42.80	56.92	85.60
12	12.090	12.50	17.80	22.68	36.20	48.60	54.00	71.82	108.00

Since the frictional resistance of pipe varies approximately as the square of the quantity of water passing, it will be convenient to combine the last 12 ft. of horizontal run with the first tee. This will give us six sections of 4-in. pipe each 12 ft. long having a connecting tee. From Table I for liquids, we find a 4-in. tee equivalent to be 4.53 ft. of 4-in. pipe making each section the equivalent of 16.53 ft. in length. From Cox's tables for flow of water through pipe lines, we find a loss of 2.563 ft. per 100 ft. for a 4-in. line handling 26.2 cu. ft. of water per min. The loss for the first section, which carries all the water, will be $16.53 \times 2.563/100$ or 0.424 ft. For the second section, which carries 5/6 of the total, the loss will be as the square of the quantity carried, or $5/6 \times 5/6 \times 0.424 = 0.295$ ft.

For the entire manifold, the losses will be as follows:

Section 1 $(6/6)^2 \times 0.424$	0.424
Section 2 $(5/6)^2 \times 0.424$	0.295
Section 3 $(4/6)^2 \times 0.424$	0.198
Section 4 $(3/6)^2 \times 0.424$	0.131
Section 5 $(2/6)^2 \times 0.424$	0.047
Section 6 $(1/6)^2 \times 0.424$	0.012
Total loss for manifold	1.107 ft.

For the remainder of the line, we have:

Suction line	10
300 diameters for pump	100
First horizontal run	50
Riser	35
Second horizontal run	108
Three 4-in. standard elbows, each 9.22	27.66
Total equivalent length of pipe to Section 1 of manifold	330.66 ft.

And from the foregoing:

Loss on 330.66 ft. at 2.563 per 100 per ft.	8.47
Loss through manifold	1.11
Total loss	9.58 ft.

TABLE II. FEET OF STANDARD PIPE EQUIVALENT TO SCREWED FITTINGS FOR LINES CARRYING VAPORS AND GASES

Nominal Pipe Size, in.	Actual Inside Diameter, in.	Gate Valve	Long-Sweep Elbow or on Run of Standard Tee	Medium-Sweep Elbow or on Run of Tee Reduced in Size 1/4	Standard Elbow or on Run of Tee Reduced in Size 1/2	Angle Valve	Close Return Bend	Tee through Side Outlet	Globe Valve
Factor of Resistance....		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
1/2	0.622	0.031	0.41	0.52	0.84	1.12	1.25	1.66	2.50
3/4	0.824	0.044	0.57	0.73	1.17	1.57	1.75	2.33	3.50
1	1.049	0.057	0.77	0.98	1.57	2.11	2.34	3.11	4.68
1 1/4	1.380	0.082	1.07	1.37	2.19	2.94	3.27	4.35	6.54
1 1/2	1.610	0.098	1.29	1.64	2.63	3.52	3.92	5.21	7.84
2	2.067	1.32	1.74	2.23	3.55	4.77	5.30	7.05	10.60
2 1/2	2.469	1.64	2.16	2.75	4.39	5.91	6.56	8.71	13.12
3	3.068	2.13	2.81	3.59	5.72	7.69	8.54	11.40	17.08
3 1/2	3.548	2.53	3.34	4.26	6.80	9.10	10.13	13.50	20.26
4	4.026	2.96	3.90	4.97	7.94	10.65	11.84	15.75	23.68
4 1/2	4.506	3.27	4.45	5.66	9.05	12.14	13.50	17.95	27.00
5	5.047	3.88	5.11	6.42	10.40	13.95	15.51	20.60	31.02
6	6.068	4.81	6.35	8.09	12.90	17.35	19.27	25.60	38.54
7	7.023	5.75	7.59	9.66	15.40	20.70	23.02	30.60	46.08
8	7.981	6.70	8.85	11.20	17.90	24.10	26.80	35.60	53.60
10	10.02	8.75	11.54	14.70	23.40	31.50	35.00	46.60	70.00
12	12.09	10.90	14.40	18.35	29.30	39.30	43.70	58.10	87.40

The total pumping loss then will be as follows:

Suction head	10.00
Elevation	35.00
Friction head	9.58
Total head	54.58 ft.

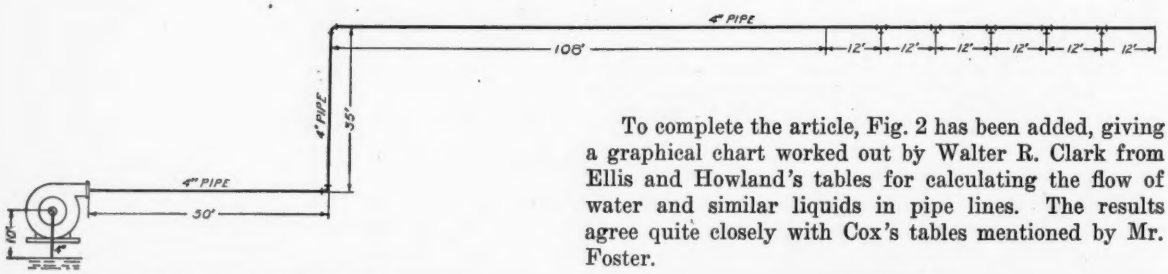

FIG. 3. LAYOUT OF WATER LINE PROBLEM

To complete the article, Fig. 2 has been added, giving a graphical chart worked out by Walter R. Clark from Ellis and Howland's tables for calculating the flow of water and similar liquids in pipe lines. The results agree quite closely with Cox's tables mentioned by Mr. Foster.

Application has been made for use of part of the flow of the north fork of Sanislaus River in California, the water to be stored in a reservoir from November to June and used, with the natural flow in summer, to develop 9600 hp. The project, including reservoir and power plant, involves an expenditure of $2,000,000 and is promoted by F. R. Pattee, of Oakdale, and S. Bernhard, of San Francisco.

THOMAS W. McNEILL

DEVELOPED A SUCCESSFUL SMOKE INDICATOR AND UNIQUE SYSTEM FOR TRANSPORTING PICKLES. PLAYED A PRINCIPAL PART IN BUILDING ONE OF THE LARGEST CANDY-MAKING PLANTS IN THE WORLD. BY WALTER PAINTER

DOWN IN THE state where blue grasses grow—the region whence come the fleet-footed race horses, the high-salaried newspaper reporters, and mellow moonshine—Kentucky, that's the state where Tom McNeill, now one of Chicago's most able engineers, chinned himself over the side of the cradle and took a first squint at this busy world. Winchester is the name of his old home town.

Thos W. McNeill

Tom's very first "position" after leaving the little red brick schoolhouse was with the Queen City Electric Light & Power Co., of Cincinnati, where he built up dynamo core laminations for the "Old Davis" machines and wondered whether he wanted to make his million in manufacturing or engineering. Engineering held the greater allure and he began his power plant career with the Citizen's Electric Light & Power Co. at Covington, Ky. Later he was invited back to Winchester to act as assistant superintendent for the Winchester Electric Light & Power Co. Here the entire transmission line was of bare copper wire with cheaply insulated leads from the poles to houses. All Tom had to do was operate the plant from 4:00 p. m. until midnight, and make line extensions, repairs, keep books and collect bills in between shifts.

Just before the close of the World's Fair, he came to Chicago and worked there for the General Electric Co. until the Fair was ended. Next he went with W. L. Abbott who owned and operated a plant down on Dearborn St. known as the National Electric Light & Power Co. This station had Russell and Ball engines belted to a half-dozen different kinds of dynamos—series arc, and bipolar direct current Edison-type machines running on the Edison three-wire system. As McNeill comments: "We had barrels of fun operating this old veteran. With no reserve units, and always loaded to the last watt, we had regular fireworks whenever a machine went out of service. Peace was declared when the "Chicago Tribune" and "Inter-Ocean" loads passed off."

When Mr. Abbott sold the plant to, and became affiliated with, the Commonwealth Edison Co., McNeill went along with him but soon afterward entered the line construction department of the same company. There he picked up some valuable experience, including a term at "trouble-shooting," without which no engineer's curriculum is really complete.

From 1894 to 1900, he worked in Chicago for such concerns as the Siemens & Halske Electric Co., the Grant Locomotive Co., the Metropolitan Elevated Railway Co., and the L. Z. Leiter Estate. He strengthened his practical experience with a correspondence school course in mechanical and electrical engineering and mechanical drawing work in an evening class at Lewis Institute. He also braved the odors of "Bubbly Creek" out at the stockyards to acquire some sound practice in refrigeration.

Then Reid, Murdoch & Co., the large wholesale grocer, got a toe hold on Tom and kept him secure and satisfied for over 15 yr. He piloted them through the establishment of seven food product factories, handling the design, erection and maintenance of all mechanical and electrical equipment, and supervising the operation of power plants. The improved methods of boiler firing which he introduced in one plant not only avoided the evils of a smoking stack but showed a saving of $400 in the monthly fuel bills even with a 10 per cent.increase in output.

Probably one of the most unique developments at Reid, Murdoch was his "system for pumping pickles." The common method of handling these pickles which were immersed in brine vats was to lift them from the vats with small dip nets and drop them on a belt conveyor. As about 10 tons were handled in an hour, it required considerable labor. McNeill's stunt was a vacuum process of lifting the pickles and the brine from the large vats with a valveless pump—which he built himself—through a 6-in. suction hose to a receiver attached to the ceiling. This receiver was designed to eject automatically and intermittently 1000 lb. of pickles and brine per minute and the whole job was done without injury to the pickles. The development of a smoke indicator, by which a shaft of light passing through the boiler breeching and projecting upon a ground glass

plate pictured the stack condition for the fireman, was another of his achievements.

About a year ago, the Bunte Candy Co., desiring to put up one of the largest candy-making plants in the world, needed the services of a man who could draw up plans and attend to the engineering equipment details. And Mr. Theodore Bunte, the president, aware of Tom's prowess with such vast projects, began to vamp him with beckoning smiles, chocolate peppermints, and more simoleons. Of course Tom accepted. Who could long resist the gratification of boyhood's dream—roaming around at will right where the peanut brittle and gum drops grow.

For the past twelve months, he has been buried to the ears in designs and lay-outs having to do with the many mechanical, electrical and refrigerating units that have gone into this huge plant, now almost completed. As an indication of output, it is worthy of note that on a single of one of the five floors more than 65 tons of candy a day will be produced. Tom has still another experience to come—Mr. Bunte has promised to teach him how to make candy one of these days.

As president of the Chicago Local No. 1, N. A. S. E., of which he has been a member for over 22 yr., as an active member of the Chief Engineers' Association of Chicago, and other organizations, Tom McNeill is giving much of his time and effort to boost the things which help the engineer and promote better power plant engineering.

Automatic Brains Still a Long Way Off

By Charles C. Phelps

"GUARANTEE that 15 per cent fuel saving you are talking about," said the hard-shelled Purchasing Agent to the CO_2 Recorder Salesman, "then I will buy the recorder and gladly pay whatever price you may ask. If you won't do this, I don't want the machine at any price." That sounded like a fair proposition—still the salesman turned it down. Was he right or wrong? Let us listen in on the ensuing conversation.

Said the CO_2 Recorder Salesman to the hard-shelled P. A.: "Do you approve of alarm clocks?"

Impatient reply: "Of course I do—used one all my life—best friend I've got. It helped me to get my present job because it always got me to work on time. You see, the big boss is a crank on punctuality."

"That must be a good alarm clock." The CO_2 R. S. saw that he was getting under the P. A.'s shell. "It was," replied the P. A., "but it *is* no more. You see, one of our best firemen, Pat, lost his wife; she had been his alarm clock for years. Then he arrived at work late day after day. The boss said, 'Let's fire the man.' I replied, 'No, let the man fire his boiler. I will give him my alarm clock to take the place of his dear, departed wife.' So I gave Pat the clock, but he continued to arrive late. His alibi the first morning was that the alarm did not go off. Investigation disclosed that he had set it the previous morning, thinking he might forget it that night, and the dinged thing was working night shift instead of morning shift. Alibi No. 2—Pat forgot the combination. Instead of moving the pointer from 'silent' to 'alarm,' he moved the regulator from 'fast' to 'slow.' That old-time ticker developed a terrible case of daylight saving. At just high noon its hands mutely proclaimed the hour of six, Pat's usual rising hour, and one click sounded. Pat arose, unaware that he had overslept, and imagine his consternation upon arriving at work to have the Chief ask him if he had spent the morning clipping bond coupons.

"That was a hard, though brief, day for Pat. That night, he took every precaution to set the regulator and alarm correctly. Promptly at six the next morning the alarm rang, but it looked more like 4 a.m. because the sky was overcast. Pat angrily threw a boot at the clock, growling, 'Dom ye, ye're lyin' ag'in!' Satisfied that he had ended the clock, he turned over to finish his night's rest. Poor Pat was demoted, but he has since found a reliable awakener. Her name is Maggie."

"Sure, that was a sad and touching tale," sniffled the CO_2 R. S. "There is only one thing you have forgotten, and that is the moral."

"Moral? Why, that's apparent," and the P. A. started to quote, "Early to bed and early to rise——"

"Nay, nay," replied the CO_2 R. S., "the real moral is this—should the maker of that clock have guaranteed that it would root its possessor out of bed at any desired time?"

Without hesitation, the P. A. responded, "For me—yes; for Pat—no."

"All right," said the CO_2 R. S., "I will guarantee 15 per cent fuel saving if you, personally, will run your recorder. Will you?"

"Of course not; my job is to buy, not to run."

"Then who will use it?"

"Tony today, perhaps Pat tomorrow," this rather meekly from the P. A.

The CO_2 R. S. saw that he was winning ground, so he asked point-blank: "If you were a manufacturer of instruments, would you, in fairness to other customers, guarantee that all comers would have sense enough and interest enough to profit by the valuable information that an instrument gives? Would you, for instance, guarantee that a water meter will make water run; that a steam flow meter will make steam flow; that a steam pressure gage will keep up steam pressure; or that a CO_2 recorder will work a miracle all by itself?"

"You are right," replied the P. A., "the CO_2 recorder tells the fireman how to keep B.t.u. out of flues, but it is up to the fireman himself to apply this information."

"How many units do you need?" asked the CO_2 R. S., with assurance.

"Six," this from the P. A.

"All right; sign here. Delivery thirty days."

"Can't you deliver right away?" anxiously inquired the P. A., as he decorated the dotted line with his autograph.

U. S. Civil Service Commission announces examinations for (1) Electric Draftsman, Office of Chief Engineers, War Department (and positions requiring similar qualifications), $1200 to $2400 a year; and (2) Shop Apprentice, $720 a year. Applications for both will be rated as received until March 1, 1921. Apply for Form 1312, stating the title of the examination desired.

Chimney Design and Construction

A Survey of the Problems Encountered in the Design and Construction of Chimneys. By Thomas S. Clark

CHIMNEYS must be designed and built not only to give adequate draft to carry away the proper volume of gases at a proper velocity, but must be built to stay there permanently and resist the attempt of the particular temperatures, dust, gases or fumes to disintegrate it, and in addition to resist the dynamic forces which tend to fell it.

There are a number of well-known types of chimneys—among them steel, concrete, a combination of concrete and tile, common brick chimneys and radial brick chimneys and even wooden chimneys.

Solution of all static and dynamic strains in a given height and diameter of a chimney is simple and much alike for all types. The manner and form of resisting these strains, however, are quite different in different types.

There is the small unlined steel stack, supported by three or more cable guys. They are not self-sustaining and depend upon the guy lines and the resistance of the steel plates and rivets for their stability.

Self-supporting steel stacks are usually of the larger type and really are not in themselves self-supporting, but are anchored to their foundations. The calculation of the compression, tension and shear is simple mechanics. The resistance to overturning is taken up first by the anchor bolts which anchor it to the foundation and secondly, by the resistance of the steel plates to moments and shear.

Fire brick is often specified in the lining of self-supporting steel stacks where the temperatures do not exceed 400 or 500 deg. F.

The concrete chimney is another type that is not self-sustaining, but is anchored to its foundation by means of reinforcing rods entering the foundation and running up into the concrete walls. The walls of the standard type of concrete chimney are thin compared with a brick chimney. The calculations for dead load and wind stresses producing the compression or tension in a concrete chimney are practically the same as the method employed in calculating brick chimneys. On the windward side there is a certain amount of tension and on the leeward side a compression.

It is usually assumed that the concrete takes none of the tension. The office of resisting tension is given to the steel reinforcing rods. Ordinarily the weight of a concrete chimney is not sufficient to make it self-sustaining without the steel rod anchors. There is, however, a type of gravity concrete chimney, in which the taper is very much increased and the walls made heavier to a point where there is no tension on the windward side. In cases of this kind the steel is not eliminated, but a certain amount, both horizontal and vertical, is placed within the walls to resist the thermal strains.

Another type is a combination of concrete and a specially formed tile, with reinforcing rods running vertically and horizontally in the walls, similar to the concrete type. A specially formed tile is used as a form for the outside, the vertical rods running through large voids in the tile.

The old, common brick chimneys, with which we are all familiar and which have stood in our early eastern communities for 100 and 150 yr., were built of burned clay, or in other words, brick. I have seen them 100 and 150 ft. high, that have withstood the disintegrating forces of time, and many are as good today as when they were built. Investigating the details of their design, I find that they were built 100 or 150 per cent heavier than was absolutely necessary and usually lined to the top with a separate core.

The inner core, extending to the top, was made necessary—a fact that the early builders realized—because *all* common brick are not made of refractory material.

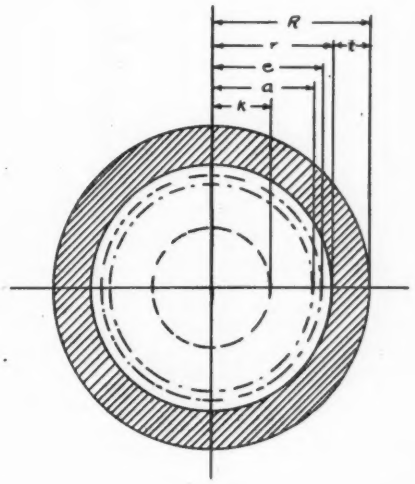

FIG. 1. SECTION THROUGH ROUND COLUMN

Most excellent examples of common brick chimneys are built today and of the same general design of lining, but of course, now that the principles of the mechanics of these structures are better known, the walls are thinner and the taper less. Even at that, a properly designed, common brick chimney, lined to the top, is a more expensive proposition than the more modern type—the perforated, radial brick chimney.

This type is constructed of bricks, or blocks, cut on radial lines to fit the several diameters of the tapering structure. As the blocks used are larger than our common brick, there are fewer joints in the chimney, and due to the fact that the blocks are cut on radial lines to fit these diameters, thinner, tighter joints are possible.

An advantage in this type of chimney is the fact that the blocks are not made of common, ordinary clay, but are manufactured from clays that are high in aluminum and high in silica, giving them not only high refractory powers but high crushing strength.

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*An abstract of a paper read before the Smoke Prevention Association.

† Chief engineer of the Alphons Custodis Chimney Construction Co.

It is seen that there are only two kinds of stresses in the ordinary height of chimney. Up to 300 or 400 ft. they are tension and compression.

In chimneys of small diameter, reaching to 400 or 500 ft. in height, it is well to investigate for horizontal and vertical shear.

The method is to treat the structure as a hollow pipe with the wind assumed as a uniform loading and by that determine the shear.

This shear is more pronounced the greater the sway, and brick chimneys do sway. We have measured the sway in chimneys, one, 375 ft. high and 7 ft. in diameter with a velocity of wind approximately 50 miles an hour, will move at the top between 6 and 8 in. The joints have a certain resilience; this resilience is given to the mortar in the joints by the use of lime.

It is a mistake to build a tall chimney of Portland cement and sand with no lime, as a structure is produced which is too rigid.

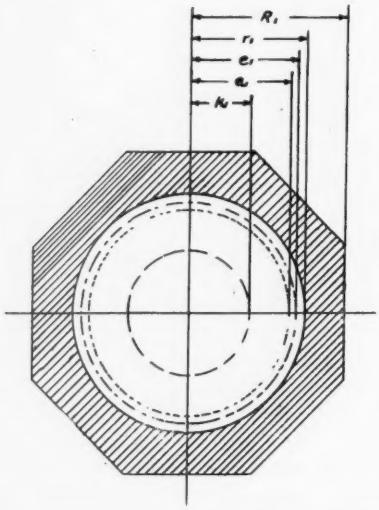


FIG. 2. SECTION THROUGH OCTAGON COLUMN

The office of a chimney is not only to carry off products of combustion or the gases from industrial processes, but to produce an adequate draft.

In the case of power house chimneys for boilers, the height and diameter must be determined by the proper number of cubic feet of gas to be forced through the fires to furnish the requisite amount of oxygen to properly and completely burn the coal. This simmers down to question of draft, and the determination of what height chimney will produce the draft.

Starting at the foot of the chimney and working back towards the furnace, the first draft loss is in the flue; how much this is depends upon the length of the flue, the material of which it is built, its cross section and the number of bends. The smoother the flue and the straighter it is, the less the loss. Sharp right-angled bends should be avoided and all changes in direction made easy. As a general rule, in steel flues of round sections, there will be a loss of 0.1 in. of 100 ft. of flue. Each right-angled turn represents a loss of about 0.05 in. If the flues are square or rectangular in shape, there will be an additional loss of 25 per cent. If the flues are built of masonry, the loss is approximately 28 to 33 per cent more; this is due, of course, to the additional roughness of the surface in the mason work.

Then we come to the loss of draft through the boiler itself; that is, from the top of the fire in the furnace to the point where the gases leave the boiler and enter the flue.

Loss of draft from this cause is dependent upon a number of factors: The type of the boiler, the number of tubes, and the way they are set.

In horizontal water-tube boilers there is a loss through the boiler at rating of approximately 0.25 in. in draft. In operating 50 per cent above rating, the loss is usually taken between 0.35 and 0.40. Operating 100 per cent above rating the loss will probably be as high as 0.55 or 0.6 in.

If the furnaces are operated in connection with a form of mechanical stoker, consideration must be given to the amount of draft required at the fire. In stokers of the V-shaped natural draft type not employing underfeed forced draft, the intensity of draft required over the fire will range from 0.25 to 0.4 in.

With the type of forced draft underfeed stokers, this requirement is somewhat different, for the reason that the gases are forced through the fire-bed and the furnace is set to operate on what is commonly called a balanced draft. In other words, it is sometimes claimed that zero draft in the case of these underfeed stokers is required over the surface of the fire in the furnace.

Testimony of a number of mechanical engineers and boiler manufacturers interviewed seems to concur that the safest method in determining the total draft loss is to allow 0.1 in. over the fires in these underfeed balanced draft appliances. It seems reasonable that there should be some power to start the gases off through the boiler towards the chimney. If this is not the case, there is liable to occur at times an overheating of the settings and doors, and possibly a pressure.

In the case of chain grate stokers, a type very successfully used with water-tube boilers in the Middle West with certain grades of coal, there is a loss of approximately 0.8 in. of draft under normal conditions at the back plate of the boiler.

These are the main considerations that must be given in determining the draft duty imposed upon a boiler chimney. These are given on the assumption that the boilers and flues are kept comparatively clean, and are for normal conditions, burning bituminous coal of normal size. Each installation, however, is a problem of its own.

Of course in the case of very fine anthracite coal, the natural draft required would call for, in some cases, a ridiculously high chimney, so that some installations where that type of coal is burned, forced or induced draft is necessary to assist a natural draft chimney.

Not many years back, when the mechanical forced draft stoker was first introduced, some mistakes were made by cutting off too much from the height of the chimney on account of the proposed use of the forced draft stoker. This resulted in the sluggish movement of the gases through the boilers with improper and incomplete burning of the coal causing damage to the arches, walls and settings of the boilers, and sometimes

a compression within the same. In such cases, it was not unusual for the boiler doors to become redhot.

As to determining the top diameter of the chimney, it is more simple and subject to less calculation than the determination of the height. The diameter must be large enough to emit the volume of gases burned per unit time at a given proper velocity. This is simple, for the velocity of the gas per minute, times the area at the top of the chimney in feet, gives the number of cubic feet of gas the area is discharging; given the number of cubic feet necessary to discharge, then the volume of gas divided by the velocity, gives the area.

Velocities of the gases vary, depending upon the nature of the boiler installation. They range from 15 to 35 and 40 ft. per second. A good general working velocity for powerhouse design handling peak loads is between 28 to 32 ft. per second. The higher of the two is good practice.

TABLE I. RADIUS OF FIRST KERN FOR VARIOUS SECTIONS

Outside Sec. / Inside Sec.	Circle		Octagon		Square		Octagon		Square		Outside Sec. / Inside Sec.
	Circle		Octagon		Square		Circle		Circle		
	$.250(1-R_1^2)$		$.244(1-R_1^2)$		$.236(1-R_1^2)$		$.676-.785R_1^4$ / $3.679-3.392R_1^2$		$1.333-.785R_1^4$ / $5.656-4.442R_1^2$		
R_0	k	y	k	y	k	y	k	y	k	y	R_0
0	.2500		.2440		.2360		.2450		.2354		0
.60	.3400	30	.3318	29	.3211	28	.3285	29	.3034	24	.60
.61	.3430	30	.3347	30	.3239	28	.3314	29	.3068	25	.61
.62	.3460	30	.3377	30	.3267	28	.3343	29	.3063	26	.62
.63	.3491	31	.3407	30	.3296	29	.3373	30	.3108	25	.63
.64	.3522	31	.3438	31	.3325	29	.3403	30	.3134	26	.64
.65	.3554	32	.3470	32	.3356	31	.3433	30	.3160	26	.65
.66	.3588	34	.3502	32	.3386	30	.3463	30	.3186	26	.66
.67	.3622	34	.3535	33	.3418	32	.3494	31	.3212	26	.67
.68	.3656	34	.3568	33	.3451	33	.3525	31	.3238	26	.68
.69	.3691	35	.3602	34	.3484	33	.3556	31	.3264	26	.69
.70	.3726	35	.3637	35	.3517	33	.3588	32	.3290	26	.70
.71	.3761	35	.3672	35	.3551	34	.3621	33	.3317	27	.71
.72	.3797	36	.3707	35	.3585	34	.3655	34	.3345	28	.72
.73	.3833	36	.3742	35	.3619	34	.3690	35	.3374	29	.73
.74	.3870	37	.3777	35	.3653	34	.3725	35	.3403	29	.74
.75	.3906	36	.3813	36	.3688	35	.3760	35	.3432	29	.75
.76	.3943	37	.3849	36	.3723	35	.3795	35	.3462	30	.76
.77	.3981	38	.3886	37	.3759	36	.3830	35	.3493	31	.77
.78	.402	39	.3923	37	.3795	36	.3865	35	.3525	32	.78
.79	.406	4	.3961	38	.3832	37	.3900	35	.3558	33	.79
.80	.410	4	.400	39	.3870	38	.3936	36	.3592	34	.80
.81	.414	4	.404	4	.3909	39	.3973	37	.3627	35	.81
.82	.418	4	.408	4	.3949	40	.401	37	.3663	36	.82
.83	.422	4	.412	4	.3989	40	.405	4	.3700	37	.83
.84	.426	4	.416	4	.403	41	.409	4	.3737	37	.84
.85	.430	4	.420	4	.407	4	.414	5	.3775	38	.85
.86	.435	5	.424	4	.411	4	.418	4	.3814	39	.86
.87	.439	4	.429	5	.416	4	.422	4	.3854	40	.87
.88	.443	4	.433	4	.419	4	.426	4	.3895	41	.88
.89	.448	5	.437	4	.423	4	.431	5	.3936	41	.89
.90	.452	4	.442	5	.427	4	.435	4	.3978	42	.90
.91	.457	5	.446	4	.432	5	.439	4	.402	4	.91
.92	.462	5	.451	5	.436	4	.443	4	.406	4	.92
.93	.466	4	.455	4	.440	4	.448	5	.411	5	.93
.94	.471	5	.459	4	.444	4	.453	5	.416	5	.94
.95	.476	4	.464	5	.448	5	.458	5	.421	5	.95
.96	.480	4	.469	5	.453	5	.463	5	.427	6	.96
.97	.485	5	.473	4	.458	5	.468	5	.433	6	.97
.98	.490	5	.478	5	.462	5	.473	5	.439	6	.98
.99	.495	5	.483	5	.467	5	.478	5	.445	6	.99
1.00	.500	5	.488	5	.472	5	.485	5	.451	6	1.00

$k = yR$

where k = radius of first kern,
and y = f(R) given in the table,
$R_0 = r + R$

where r = inside radius of section,
and R = outside radius of section.

The composition of gases from the several grades of coal is generally known. The volume as well as the weight is easily computed for given temperatures.

With a rational assumption of coal economy, i. e., 3 or 4 lb. of coal per hp. per hour, the total amount of coal to be burned will give off a known total volume of gas. That with the correctly assumed velocity, fixes the area of the top of the chimney.

Draft, as we all know, is due to the difference in weight and temperature of the column of gas in the chimney and a like column of external air, minus the loss due to friction inside the chimney. Many formulas express this to a practical nicety and I will not take time to discuss them because it is one of the features that can be found in text books.

The all-important problem is the solution of the actual inches of draft required at the foot of the chimney, giving careful consideration to all draft losses from the several apparatuses that make up the boiler plant. Practical experience, good judgment, and a study of these apparatuses is required for each installation and no one can lay down fixed rules to fit all cases.

Method of Calculating the Stresses in a Brick Chimney

Symbols:—

G = Weight of brickwork above section.
W = Wind pressure above section in tons.
W_1 = Wind pressure on base.

TABLE II. RADIUS OF SECOND KERN FOR VARIOUS SECTIONS

Outside Sec. / Inside Sec.	Circle		Octagon		Square		Octagon		Square		Outside Sec. / Inside Sec.
	Circle		Octagon		Square		Circle		Circle		
	$\frac{9.4248}{16}\frac{1-R_1^4}{1-R_1^2}$		$.4392\frac{(1-R_1^4)}{(1-R_1^2)}$ / $.7240\frac{1-R_1^4}{1-R_1^2}$		$\frac{2}{3}\frac{(1-R_1^3)}{1-R_1^2}$		$.4392-.3927R_1^4$ / $.7240-.6667R_1^2$		$.6667-.3927R_1^4$ / $1.0000-.6667R_1^2$		
R_0	e	d	e	d	e	d	e	d	e	d	R_0
0	.589		.593		.667		.593		.667		0
.60	.653	3	.657	3	.738	3	.695	3	.716	3	.60
.61	.656	3	.660	3	.741	3	.671	3	.721	3	.61
.62	.659	3	.663	3	.745	3	.674	3	.724	3	.62
.63	.662	3	.666	3	.748	3	.677	3	.726	2	.63
.64	.664	2	.668	2	.751	3	.680	3	.728	2	.64
.65	.667	3	.671	3	.754	3	.682	2	.731	3	.65
.66	.670	3	.674	3	.757	3	.684	2	.733	2	.66
.67	.673	3	.677	3	.760	3	.687	3	.736	3	.67
.68	.676	3	.679	2	.763	3	.690	3	.738	2	.68
.69	.678	2	.682	3	.766	3	.693	3	.740	2	.69
.70	.681	3	.685	3	.769	3	.696	3	.742	2	.70
.71	.684	3	.688	3	.773	4	.699	3	.745	3	.71
.72	.687	3	.691	3	.776	3	.702	3	.747	2	.72
.73	.690	3	.694	3	.780	4	.705	3	.749	2	.73
.74	.693	3	.697	3	.783	3	.708	3	.752	3	.74
.75	.696	3	.700	3	.787	4	.711	3	.754	2	.75
.76	.699	3	.703	3	.791	4	.714	3	.756	2	.76
.77	.702	3	.706	3	.794	3	.717	3	.759	3	.77
.78	.705	3	.709	3	.797	3	.720	3	.762	3	.78
.79	.708	3	.712	3	.800	3	.723	3	.765	3	.79
.80	.711	3	.715	3	.803	3	.726	3	.767	2	.80
.81	.715	4	.719	4	.807	4	.729	3	.770	3	.81
.82	.718	3	.722	3	.811	4	.732	3	.773	3	.82
.83	.722	4	.726	4	.816	5	.736	4	.775	2	.83
.84	.726	4	.730	4	.820	4	.740	4	.777	2	.84
.85	.730	4	.734	4	.824	4	.744	4	.780	3	.85
.86	.733	3	.738	4	.828	4	.748	4	.783	3	.86
.87	.737	4	.741	3	.833	5	.752	4	.786	3	.87
.88	.740	3	.744	3	.837	4	.756	4	.789	3	.88
.89	.744	4	.748	4	.841	4	.760	4	.792	3	.89
.90	.748	4	.752	4	.846	5	.764	4	.795	3	.90
.91	.752	4	.756	4	.850	5	.769	5	.798	3	.91
.92	.756	4	.760	4	.854	4	.773	4	.801	3	.92
.93	.759	3	.764	4	.858	4	.778	5	.804	3	.93
.94	.762	3	.767	3	.862	4	.782	4	.806	2	.94
.95	.766	4	.770	3	.866	4	.787	5	.809	3	.95
.96	.769	3	.774	4	.870	4	.792	5	.812	3	.96
.97	.773	4	.778	4	.874	4	.797	5	.815	3	.97
.98	.777	4	.782	4	.878	4	.802	5	.818	3	.98
.99	.781	4	.786	4	.883	5	.807	5	.820	2	.99
1.00	.785	4	.790	4	.889	6	.812	5	.822	2	1.00

$e = dR$

where e = radius of second kern,
and d = f(R) given in the table,
$R_0 = r + R$

where r = inside radius of section,
and R = outside radius of section.

S = Distance from section to center of wind pressure in feet.
S_1 = Lever arm of wind on base.
M = Moment of outer forces above section.
A = Area of section in square feet.
V = Section modulus in feet cubed.
K = Maximum and minimum stresses in tons per sq. ft.
D_1 = Outside diameter at top in feet.
D_2 = Outside diameter at section in feet.
D_4 = Inside diameter at section in feet.
P = Intensity of wind pressure on a plane in pounds per sq. ft.
H = Total height of circular shaft above section.
H_1 = Height of base above section.

Formulas:—

For section through a circular shaft having a batter:

$$W = \frac{D_2 + D_1}{2} \times \frac{PH}{2 \times 2000} \qquad V = 0.0982\left(D_2^3 - \frac{D_4^4}{D_2}\right)$$

$$S = \frac{D_2 + 2D_1}{D_2 + D_1} \times \frac{H}{3} \qquad K = \frac{G}{A} \pm \frac{M}{V}$$

$$M = W \times X$$

$$A = 0.7854\ (D_2^2 - D_4^2)$$

For a section through a plumb octagonal base having a circular interior:

$$W_1 = \frac{H_1 \times D_1}{2000} \times \frac{3P}{4}$$

$$S_1 = \frac{H_1}{2}$$

$$M_1 = W_1 S_1 + W H_1 + M$$

$$A = 0.8284\, D_2^2 - 0.7854\, D_4^2$$

$$V = 0.1095\, D_2^3 - \left(0.0982 \times \frac{D_2^4}{D_2}\right)$$

$$K = \frac{G}{A} \pm \frac{M}{V}$$

STRESSES IN SECTION THROUGH ROUND COLUMN

Specifications:—

1. The theoretical compression and tension must not exceed safe limits.

2. If the theoretical tension exceeds its safe limit the resultant must fall inside the second kern, and the maximum compression must not exceed its safe limit.

Formulas:—

$$W = \text{wind pressure} = \frac{(D_1 + D_2)\, HfP}{4000} \text{ (tons)}$$

$$S = \text{lever arm} = \frac{(2D_1 + D_2)\, H}{(D_1 + D_2)\, 3} \text{ (ft.)}$$

M = wind moment = $W \times S$ (ft.-tons)

Note: If the column has a variable batter the wind moment on each trapezoid must be computed separately as above. The wind moment at the foot of the column is then the combined moments of the wind on these trapezoids.

$$G = \text{dead weight} = \frac{V_1 w}{2000} \text{ (tons)}$$

$$a = \text{radius of resultant} = \frac{M}{G} \text{ (ft.)}$$

k = radius of first kern = yR (ft.)

e = radius of second kern = dR (ft.)

A = net area of section = $(D_2 - t)\, 3.1416 t$ (sq.ft.)

$$S' = \text{theoretical compression} = \frac{G}{A}\left(1 + \frac{a}{k}\right)$$

(tons per sq. ft.)

$$S'' = \text{theoretical tension} = \frac{G}{A}\left(1 - \frac{a}{k}\right) \text{ (tons per sq. ft.)}$$

If S'' exceeds the safe stress for brickwork, then S''' = maximum compression = $S' - S''\left(\frac{a - k}{e - k}\right)^2$ (tons per sq. ft.)

Note: The first kern is the area in which the resultant must fall if there is to be no tendency for the chimney to open beyond an axis normal to the wind through the center of the section.

Notation:

f = wind factor used for round columns.

V_1 = volume of brickwork above section in cu. ft.

w = unit weight of brickwork in column in lbs. cu. ft.

R = outside radius at section in feet.

r = inside radius at section in feet.

R_0 = ratio of inside to outside radius = $\frac{r}{R}$

t = wall thickness at section in feet = $(R - r)$.

d = factor taken from Table II with R_0 as argument.

y = factor taken from Table I with R_0 as argument.

STRESSES IN SECTION THROUGH OCTAGON BASE

Specifications: Same as for round column.

Formulas:

$$W_1 = \text{wind pressure on base} = \frac{D_3 H_1 f_1 P}{2000} \text{ (tons)}$$

$$S_1 = \text{lever arm of } W_1 = \frac{H_1}{2} \text{ (ft.)}$$

$$M_1 = \text{wind moment} = M + W H_1 + W_1 S_1 \text{ (ft.-tons)}$$

$$G_1 = \text{dead weight} = G + \frac{V_1 w_1}{2000} \text{ (tons)}$$

$$a_1 = \text{radius of resultant} = \frac{M_1}{G_1} \text{ (ft.)}$$

k_1 = radius of first kern = $y R_1$ (ft.)

e_1 = radius of second kern = $d R_1$ (ft.)

A_1 = net area of section = $3.314 R_1^2 - 3.1416 r_1^2$ (sq. ft.)

$$S_1' = \text{theoretical compression} = \frac{G_1}{A_1}\left(1 + \frac{a_1}{k_1}\right)$$

(tons per sq. ft.)

$$S_1'' = \text{theoretical tension} = \frac{G_1}{A_1}\left(1 - \frac{a_1}{k_1}\right)$$

(tons per sq. ft.)

If S_1'' exceeds the safe stress for brickwork, then S_1''' = maximum compression = $S_1' - S_1''\left(\frac{a_1 - k_1}{e_1 - k_1}\right)$

(tons per sq. ft.)

Note: The first kern is the area in which the resultant must fall if there is to be no tension in the section. The second kern is the area in which the resultant must fall if there is to be no tendency for the chimney to open beyond an axis normal to the wind through the center of the section.

Notation:

D_3 = width of base across flats in feet.

f_1 = wind factor used for octagon bases.

V_1 = volume of brickwork in base above section in cu. ft.

w_1 = unit weight of brickwork in base in lbs. per cu. ft.

R_1 = half the width of base across flats in ft.

r_1 = radius of inside bore in ft.

R_0 = ratio of r_1 to R_1 = $\frac{r_1}{R_1}$

Ice Protection for Hydroelectric Plant

Methods of Deflecting Ice Jams. By John S. Carpenter

TO START now and preach preparedness for ice troubles of the coming winter is hardly untimely. To be brutally frank about it, all such preparations should have been completed before Labor Day; especially if any concrete work was included in the program. Eleventh hour work and repentance are both dangerous, the former where it involves concrete for ice protection, because the concrete does not have the necessary time to age and attain safe values of strength. This last remark concerning strength may appear a trifle dubious or far-fetched to some, but those who have seen what tremendous forces are met with in comparatively small ice jams and have seen the effects produced, will not be inclined to minimize the element of safety.

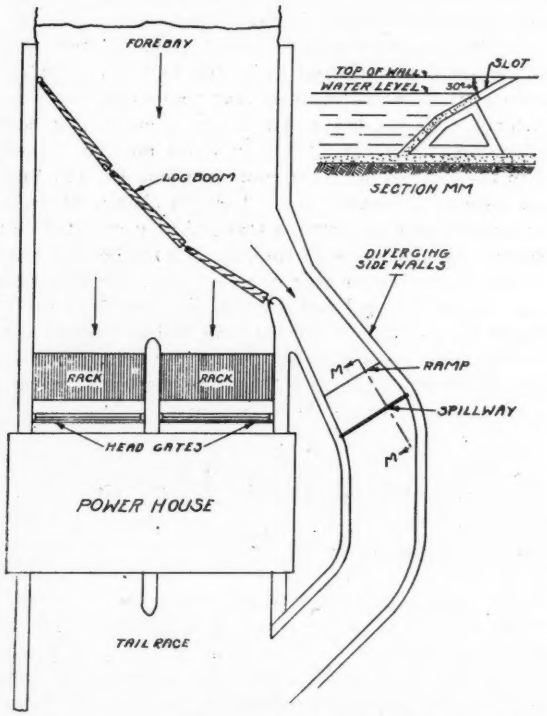


FIG. 1. LOG BOOM STRETCHED ACROSS THE FOREBAY TO BYPASS ICE

The field of this article is ice protection for the small and medium sized plant. As a rule, the larger plants are provided with suitable means of protection when they are being designed, and such design is usually placed in the hands of competent engineers. Smaller and medium sized plants are usually built first and designed later. The owner often does his own engineering, drawing on his rich experience of perhaps 40 yr. in human nature, and like the translator who learned his Spanish from cigar bands, he "gets by" somehow. So it is usually after a hard winter's tussle with ice troubles that some earnest thought is given to "what we'll do for next winter."

There are two methods of handling the ice problem just as there are two ways of treating a headache. If you have a headache, are you going to take a powder and relieve the headache or are you going to get at the cause of it? The first can be called palliative, the second, preventive. The second method, that of prevention, is the only logical treatment in the case of either headaches or ice troubles. To get rid of the ice up at the forebay and prevent its passing through the plant, is the one best bet.

As to prevention, there are the following, which have shown their worth by actual operation.

(a) A log boom placed across the channel at about 45 deg., the discharge end of which deflects or guides the floating ice into a suitable receiving basin, whence it can

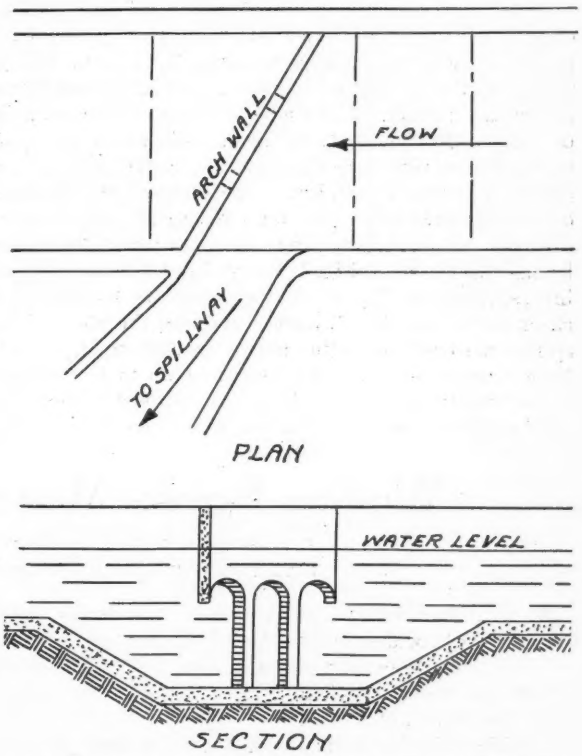


FIG. 2. ARCH WALL BUILT ACROSS THE CHANNEL TO DEFLECT ICE ACCUMULATIONS

be discharged over a spillway or sawed up for storage. If the spillway mentioned is properly designed, the pressure of accumulation will force the ice over the spillway apron without manual aid, save perhaps in the case of very large pieces.

(b) A submerged arch, or series of arches, inclined to the channel width at not less than 30 deg., the crowns of the arches being submerged from 30 to 42 in., according to climate. As in the case of the log boom, the ice is to be deflected or guided into a receiving basin and from there discharged over a spillway.

(c) Where Taintor gates are used in cases of waste spillways, or in cases where such gates are used as the

means of draining the turbine pits, conditions will arise that will cause the gates to be solidly frozen in. In such cases the plant cannot be started; so it is good practice to box in the top and sides of the gate nearest the power house and to put a generous sized steam coil inside of the gate. This will melt the ice around that one gate, and as soon as the flow is started, the other gates will thaw out successively.

(d) In very cold climates, ice will form around the speed rings of the turbine, and clogging of the water passages will soon follow. This has been prevented by putting two coils of pipe around the crown plate and two coils around the bottom plate of the turbine and connecting the two by means of vertical drop legs placed just outside of the guide vanes in the speed ring.

(e) The writer understands that some effort has been made to use traveling screens to keep the turbine pits free of ice, but unfortunately, data on their cold weather performance is not available.

The log boom is made up of good sized tree trunks, of length to suit the location and connected by means of pieces of heavy chain usually about 3 ft. long, firmly spiked to the log ends. Figure 1 shows the log boom across the channel. The ice as it comes downstream, is deflected into the receiving basin and the pressure of accumulation will force the blocks over the ramp of the spillway. From the spillway, the disposal will depend on the topography of the site. Where the entire river discharge passes through the plant, the ice spillway can be made as shown in Fig. 1, the spillway discharge going into a tumbling bay connected with the tailrace, the effect being that the ice merely bypasses the plant. The spillway, somewhat better shown in section M, should have a concrete slab ramp extending up to the normal winter water stage, and above the slab slots should be cut in the side walls so that the water can be saved by putting in stop logs in case the water should be abnormally high. To make the receiving basin self-clearing and avoid ice jams therein, the side walls should diverge about 1 ft. in each 10 ft., so that the channel increases 1 ft. in width in each 5 ft. of run.

In some cases in the colder climates, a log boom alone will not be sufficient. The logs, at the most, will probably sink only 12 to 18 in. below the water surface and quite a few good sized ice chunks will be carried under the logs by the current. Here the submerged arch will give good results alone, although the writer recommends that it be used in connection with the log boom. Refer to Fig. 2. Such an arch wall should not be less than 12 in. thick unless it is short and very well reinforced. The wall should be set at not less than 30 deg. with the width of the channel and like the log boom, it should guide the ice over a spillway or into a receiving basin. Since the immersed section of the arches, together with the piers, take up a considerable portion of the cross-sectional area of the channel, the channel should be made correspondingly deeper at that point.

As to the steam heated Taintor gate, it is merely the conventional form boxed in on top and the sides. The bottom must be left open so that water can freely come in touch with the heated air of the interior. The steam inlet should come in at a high point and be connected with the coil by flexible steam hose long enough to permit opening the gate fully. The coil should be drained by gravity and the returns trapped or gravitated to the boiler. As to the size of the coil, it must be said that it is wise to err on the side of generosity. Strictly speaking, the coil is used for starting the flow only and the larger the coil the sooner the gate will be thawed out.

The same reasoning applies to the coils around the turbine speed ring, except that occasions may arise when it is necessary to use these continuously.

Wasting Surplus Water at Hydroelectric Plants

A Description of the Various Kinds of Gates Used to Regulate the Overflow in Hydroelectric Stations. By L. W. Wyss

ARRANGEMENTS FOR WASTING excess water are provided by the use of Taintor gates, sluice gates, bear trap gates, automatic rolling gates, automatic flash boards and gate or flutter valves located near the bottom of a dam.

Wide spillways without gates are also used to waste excess water. When flash boards are installed, their purpose is rather to increase the effective head and storage of the river than to waste water. This also may be said of needle stop logs, excepting where they are used instead of gates at the older dams.

Taintor Gates

Taintor gates are now one of the most widely used gates. They can be raised or lowered easily, as the pressure of the water is taken care of with bearings.

Either hand, motor or interchangeable hand and motor driven hoists are used to operate them. When each gate is not provided with an individual hoist a track is laid on top of the dam to carry a portable hoist. Care should be taken with this type of gate to prevent logs or large cakes of ice jamming them and that the lifting chains pull equally, otherwise the gate may be wrenched out of shape which will interfere with their successful operation. Turn-buckles are used on these chains for adjustment. Stop log grooves are usually provided in the dam structure to facilitate work which would require that the water be shut off from the gate. It is difficult to fit stop logs so that no leaks appear, but these can be stopped with cinders.

Sluice Gates

A wide variety of sluice gates are in use. When these gates are provided at the crest of the dam, they are often lowered to waste water. They are therefore very convenient for sluicing ice, logs and other river trash.

It is usual to find booms which bypass this trash through sluice gates so that very little reaches the trash racks. When these gates are built primarily for discharging trash, they are sometimes built rather small so that a minimum of water is used in discharging the trash.

Rack and pinion operated gates are in common use.

One or two rack stems are bolted to the gates and the pinion can be back geared for motor, manual or interchangeable operation.

If the gates are designed for hand operation, either hand wheels, cranks or levers are supplied. Some sluice gate hoists have arrangements provided to shift gears so that the operator can select the gear ratio best suited to the conditions. Where a worm gear is used in the hoist it is convenient because it holds the gate in any position without the use of a brake or stopdog. These gates can be built bearing on rollers so that there is much less friction.

Sluice gates located near the bottom of a dam are very convenient for wasting water in a freezing climate, as the operating stem is the only part which freezes fast and this is not hard to chop free.

These gates waste a large amount of water for their size. For example, a four by four gate at a depth of 29 ft. discharges 430 cu. ft. per sec. This type of gate has been used to render a double service at plants where the tail water rises high enough to curtail the station output during floods. The gates are located so that the water discharging into the draft tube results in an increase of power output of the turbines.

Some sluice gates are provided with adjusting wedges to take up the wear if the gate becomes leaky after long usage. These submerged sluice gates are very similar to large gate valves which are also used for similar purposes, so it may be well to consider them at the same time.

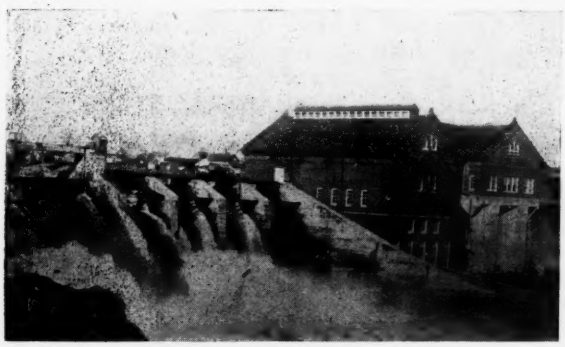


FIG. 1. INSTALLATION OF TAINTOR GATES AT THE CROTON DAM NEAR NEWAYGO, MICH.

Both rising and nonrising spindles are used to operate this type of gate. The rising spindle has been found more satisfactory, because the threaded portion can be kept lubricated above water and it serves as an indicator showing the gate opening. If the gates are hand or motor operated, a floor stand is provided with suitable gearing to operate the spindle.

Hydraulic and pneumatic cylinders are also used to operate these gates, in which case remote control by means of valves can be resorted to, or a motor operated valve near the gate can be controlled from a distant point such as the power or gate house.

Bear Trap Gates

Overflow or bear trap gates are raised and lowered like a trap door, being hinged on the lower edge. Chains or cables are used to lift them. They are built very wide at some installations where it is necessary to sluice large trees or cakes of ice.

Automatic Rolling Gates

Automatic rolling gates are not used very extensively. They are operated by the pressure of the impounded water. When the water rises, the increasing pressure on the lower side of the gate turns it over so that the water flows under it and above it until the head water reaches normal again, in which case the gate swings in the closed position.

Automatic Flashboards

Automatic flashboards will be described as used at the spillway of a large Southern dam. The flashboards are similar to a bear trap gate hinged on the lower edge and controlled by rolling counterweights so arranged that the elevation of the reservoir raises only 3 in. when the battery of flashboards waste 12,000 cu. ft. of water per second.

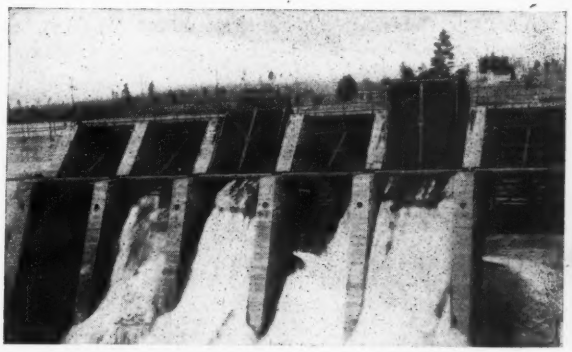


FIG. 2. GATES WASTING SURPLUS WATER AT A DAM IN NORTHERN MICHIGAN

The counterweights are concrete cylinders 26 ft. long and 3.25 ft. in diameter and are fitted at each end with heavily geared rolling contacts, which roll on especially curved racks attached to the side of the piers above the crest. As the flashboards are lowered, owing to the pressure of the water the counterweights are forced up the incline by the pull of steel cables wound on a drum at either end of the counterweight and connected to the top of the flashboards. Hand-operated hoists are provided to manipulate the flashboards if a different reservoir elevation is desirable from that which the flashboards maintain automatically.

Butterfly Valves

Butterfly valves are often called pivot valves. They are either hand, motor or hydraulically operated and are usually located near the bottom of a dam, like submerged sluice gates and gate valves. They will not freeze here unless exposed too much on the down stream side of the dam and waste a large amount of water for their size. A dam in New York is provided with two butterfly valves 100 ft. below the crest of the dam. They control the outlet of two 6-ft. steel pipes and can be used to drain the reservoir, if necessary, as well as to waste excess water. At normal head water elevation they discharge about 1500 cu. ft. per sec.

Head Gates

What has been said regarding gates in general will also apply to head gates which are located at the head of flumes, penstocks or tunnels.

Gates are placed at the head of a flume to regulate the water flowing into it. In this case electrical operation is best adapted, as the motors can be controlled from the power house or by the use of a float switch.

At many developments, filler valves are used to fill the penstocks before opening the head gates. These may be small valves or sluices built in the head gates or valves and piping arranged to connect an empty penstock to the forebay or an adjacent penstock which is full.

These valves serve a double purpose. First, they fill the penstocks slowly to prevent dangerous penstock pressures or water hammer. Second, they equalize the pressure on the head gate when the hoisting equipment provided is not capable of opening them under pressure.

Figure 3 shows how these valves may also be arranged to serve as drain valves when the pipe connections to the penstock are placed to drain the seepage from a

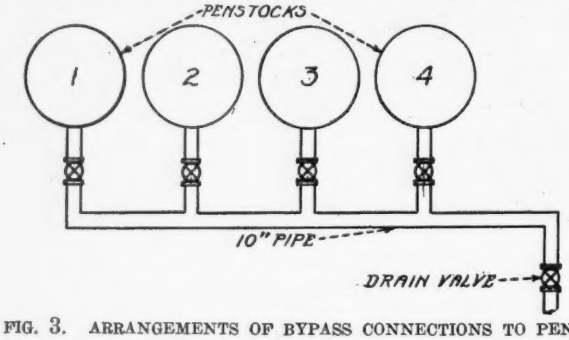


FIG. 3. ARRANGEMENTS OF BYPASS CONNECTIONS TO PENSTOCKS

closed head gate, thereby preventing this seepage from reaching the turbine where it would hamper the inspections or repairs under way.

When a penstock is filled, the drain valve is closed and water is taken from any penstock which is full.

Where filler valves are not provided, it may be necessary to open the head gate partly, and then wait for the penstock to fill slowly, thus eliminating that high pressure and water hammer as mentioned before.

At one installation, the gates are equipped with automatic control devices consisting of a limit switch geared to the sluice gate stems and a float actuated by the water in the penstocks. When the gates are opened enough so that the penstock can be filled in 5 min., the limit switch opens and stops the motor. When the penstock is filled, a float switch starts the motor and another limit switch prevents over travel. The gate is closed by reversing the control switch at the power house, and a limit switch again stops the motor when the gate reaches its closed position.

In order to facilitate handling or to save head room in gate houses, sluice gates may be built in detachable sections, in which case cranes or hoisting winches are used to handle the gates. Where a failure of the turbine governors will result in dangerous over speeding, it may be desirable to have the head gates close automatically. This may be done electrically with a centrifugal switch. Tripping ropes from the head gates may also be arranged so that an operator can trip any head gates from the power house, the gate closing by gravity.

When gates are remotely controlled, the gate opening can be shown with suitable signal lamps.

Timber Flap Gates

At one plant in Canada, two timber flap gates are used to close each half opening of the entrance to a penstock. These gates differ somewhat from the ordinary as they are hinged at the bottom and are provided with concrete counterweights at the top, which keep them open under normal conditions. They swing in a manner similar to a wagon box end gate and when open they rest on a concrete sill at an angle of about 45 deg. from vertical, so that hoisting can be done easily. As all parts of these gates are submerged below the point of freezing, they make very good gates for a cold climate.

Steel gates are also built in this way, and at one plant the power house crane handles them.

Operating Gates

Two sources of power for handling gates which have not been mentioned are gasoline engines and small water wheels. At one place, of which the writer has heard, a gasoline engine is used to operate the gates at the intake of a long flume, while at another place, gates are handled with a 25-hp. water wheel, clutches being provided to connect the gate raising mechanism of any gate to a long shaft, which is driven by the wheel.

Coal Situation in Southern Wyoming

By J. B. Dillon

The report of Robert T. Sneddon, state coal mine inspector for Wyoming Dist. No. 1, is such a cheering one that it makes it a real pleasure to send it along.

That there will be an increase of coal production in 1920 to the amount of 1,500,000 tons over 1919, seems absolutely certain. The first 6 mo. of 1920 show 2,220,639 tons, which is an increase of 768,882 tons, or 34½ per cent over the same period for 1919.

For those interested, the tabulated statement is appended:

County	Production in 1919	Production in 1920	Increase	Percent Increase
Sweetwater	1,301,902	1,878,306	576,404	44
Carbon	259,827	334,844	75,017	29¼
Lincoln	645,607	753,605	107,998	16⅔
Uinta	13,303	22,766	9,463	71
Totals	2,220,639	2,989,521	768,882	34½

The Bureau of Mines states that it has made several favorable co-operative agreements for research work in special fields with state institutions, engineering colleges and private companies. The Bureau is desirous of adding to these arrangements so as to extend the field of its activities and to give such work the prestige of being carried out under auspices of the Bureau.

Country's Oil Supply Limited

OPINIONS EXPRESSED BY INVESTIGATORS AT MEETING IN SAN FRANCISCO

WORLD shortage of gasoline never will be relieved and the future of the motor industry, with special reference to power from petroleum hydrocarbons, is precarious, according to a statement issued in San Francisco recently by Dr. C. F. Mabery, professor-emeritus of Case School of Applied Science, Cleveland, Ohio, and recognized by the United States Geological Survey as an authority on hydrocarbons, oils and asphalts. Dr. Mabery was in San Francisco following extensive investigation into fuel conditions in Alaska. While in San Francisco Dr. Mabery talked before various organizations of chemists and practical oil men.

SITUATION IS GRAVE

COMMENTING on various phases of the petroleum industry, he asserted that the essential gravity of the situation apparently has not impressed itself upon the people of this country. Automobile owners and other users of gasoline, he said, are harboring hopes that never will be realized, when they look forward to return of the old days of pure gasoline. Inferior products and constantly increasing prices will mark the future of the motor industry, not only in this country but throughout the world, is his belief.

Discussing more or less in detail the petroleum situation facing the world, Dr. Mabery declared that his judgment as to the future is based on knowledge of oil fields already exploited, and possibilities of expansion in various countries. China, he asserted, is practically the only country whose possibilities along the line of petroleum production are not fairly well known.

"It is the consensus of opinion of Government officials, experts, manufacturers and producers, that there is no more important element entering into present or prospective industry and commerce than that relating to the world's supply of bitumens, which include various kinds of coal, asphalts, petroleum, natural gas and bituminous shales and peat. The question often is asked by the laymen as to the origin of the world's supply of these materials and their extent. Also as to the present rate of consumption and the prospect of additional supply by further natural formation.

"This brings us to the question as to whether this supply was formed by natural conditions in early geological periods, or whether formative conditions already are in operation whereby the natural supply is being renewed. As the result of study and investigation but one conclusion can be drawn. Nature did its work in the earlier ages and what then was accomplished never can be repeated on this planet.

"The opinion formerly was held by eminent authority, led by the great Russian chemist, Mendelejeff, that the bitumen petroleum was early formed and still is in process of formation from metallic carbides within the hot interior of the earth and that it was brought out by volcanic action and lodged in the rock strata where it now is found.

"In addition to all other evidence opposing this theory, we have before us at present complete refutation of this theory, by operation of the great volcanoes, such as the great Katmai district in Alaska and the explosion at St. Pierre a few years ago, in which disturbances no indication of petroleum or any of its constituents have been observed. In addition to this the enormous heat would preclude the possibility of existence of any hydrocarbons contained in petroleum.

"There seems now to be a unity of opinion on the part of geologists, chemists and petroleum engineers that the formation of petroleum was due to decomposition of vegetable and animal matter at comparatively low temperatures, perhaps aided by high pressures within the rock strata where it is found at present.

PUREST SUPPLY

"THE PUREST PETROLEUM is that found in the Appalachian district, comprising the fields in Pennsylvania, West Virginia and Kentucky. There seems to be ample evidence that the formation of petroleum here was either co-incident or closely related to the formation of coal, all from the great areas of vegetation of the carboniferous period. As additional evidence of its genesis from organic matter, this petroleum contains a certain percentage of nitrogen compounds that could be derived only from some form of organic matter.

"Assuming a scale of various varieties of petroleum, with the light Appalachian oil at one end and the heavy asphaltic petroleum of Texas and California at the other end, we have between these two limits the numerous fields of oil in the mid-continental districts comprising the oil fields of Ohio, Indiana, Illinois, Kansas, Wyoming and Oklahoma. These heavier oils contain variable proportions of sulphur and nitrogen derivatives as impurities, which affect the value of the crude oil and modify the methods of refining them.

SUBSTANCE UNIFORM

"PETROLEUM HAS received a variety of definitions based upon its composition, but comparison has shown that from whatever source it is one and the same substance—a mixture of hydrocarbons in variable proportions, and the refiner finds it necessary to adapt his method of treatment to the nature of its composition. The larger part of normal gasoline is obtained from the pure petroleum. The heavier varieties of petroleum, such as those found in Texas and California, can not be depended upon as sources of normal gasoline.

"With the enormous increase in the number of motor cars, normal gasoline could meet only a small proportion of the demands for motor fuel. The refiner necessarily turned his attention to methods whereby the supply could be increased and it was found that by process of 'cracking,' which consists in heating crude petroleum in stills or passing vapors through highly heated pipes, a fairly satisfactory motor fuel oil could be obtained. The use of kerosene has been suggested as a substitute, but this former by-product has become almost as expensive as gasoline."

Dr. David White, of the Bureau of Mines, predicted that at the present rate California within 2 yr. will be dependent entirely on mid-continent sources and Mexico for her oil and gasoline. He pointed out that the recent jump in production in the mid-continent fields was what saved the California situation. It was explained that the increased gasoline production, which in May attained a record output, was due in part to the recently adopted practice of utilizing lower grades of oil in gasoline.

The cost of field operations in producing crude oil in California has increased 200 per cent, or possibly 300 per cent, during the past 5 yr., according to statistics recently published by the State Mining Bureau. In 1913 the operating cost was generally less than 20 cents per barrel, while in 1919 the figure was in the neighborhood of 40 cents or more. Decrease in productiveness of wells, coupled with advanced cost of labor and material, are the underlying reasons.

The total capital invested in the oil industry is about $320,000,000, upon which dividends of $35,418,851 were paid, or at a rate of about 11 per cent.

About two-thirds of the total output of crude oil is refinable, or above a gravity of 18 deg. Baumé.

The total area of proved oil land is 91,792 acres, or about 143 sq. mi. Upon this land there are 8928 producing wells, slightly more than 10 acres per well. Future drilling will probably increase the number of wells until the average amount of land drained by a single well will be about seven or eight acres.

W. W. Woods, vice-president of the First National Bank of Los Angeles, who has made a deep study of the oil situation, in an article in the Los Angeles Times tells why he believes fuel prices are to show further rises:

"As long as the law of supply and demand continues to function, no power on earth, except the establishment of priorities and the rationing of oil and gasoline to essential industries, with the consequent elimination of the pleasure automobile, can stop a steady increase in the cost of gasoline and oil to the consumer.

Demand Is Increasing

"In the last 2 yr. the growing appetite of the internal combustion engine for gasoline has been more than six times what it was in 1901. The demand for oil has grown from 70,000,000 bbl., in 1900 to 433,500,000 bbl. in 1919.

"The United States Geological Survey is the authority best qualified for an opinion upon the oil situation in America. Its geologists estimate that already we have taken 5,000,000,000 bbl. of oil from American fields, and that there are only 6,500,000,000 bbl. left. At the rate at which we are now consuming oil, the estimated supply will last less than 18 yr., but if the increased rate of consumption keeps up our stocks will be gone much sooner.

"Last year approximately 29,000 wells were drilled in the United States as against 25,500 in 1918. An oil well in Pennsylvania costs $10,000; in California, $100,000, and the total cost for the 29,000 American wells drilled last year was more than $600,000,000—this tremendous sum was spent to increase our oil production by only 22,000,000 bbl.

More Than Half Gone

"America today produces 70 per cent of the world's oil supply but over 60 per cent of our oil reserve is already exhausted. Wherever possible, European nations are shutting American producers out of foreign fields. What then of the future? Throughout America we must turn to electric power. On the Pacific Coast it must be hydroelectric; in the East this power must be based largely upon coal consumption.

"This means that the oil-burning transcontinental trains west of the Rockies must give way to the electric engine. Electricity must also take the place of oil combustion in the East, and the oil itself must be turned into lubricants instead of being used to furnish motive power.

"With the present ratio of supply and demand, there must inevitably follow a steady increase in the price of oil and gasoline itself. Here on the Pacific Coast the present year's demand for oil is approximately 110,000,000 bbl., and the production is 10,000,000 bbl. below that point, while the oil stocks on hand during the first 6 mo. of the present year have been decreased at the rate of more than 28,000 bbl. a day, or a total of more than 5,000,000 bbl. during the first half of this year alone.

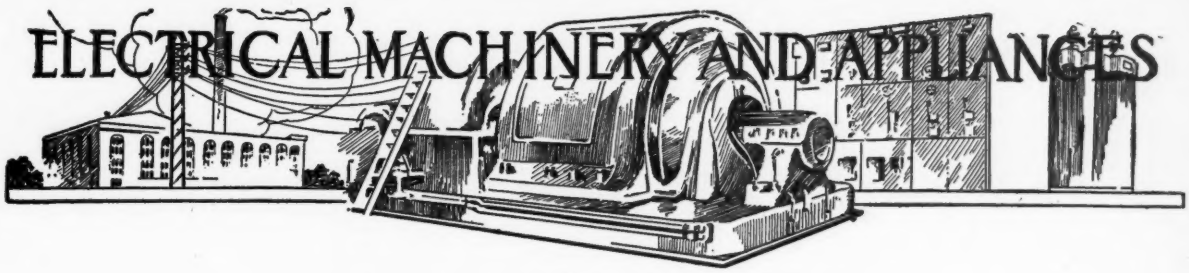
"Already the Southern Pacific has made a complete study of the problem of electrifying its lines over the mountains between Los Angeles and San Francisco.

"Electric power is rapidly taking the place of the gasoline engine for irrigation pumping throughout California, and even in the California oil fields, themselves, due to oil scarcity, and due to the oil demands, where electric power is not available, the cost of oil is so great at the very wells that electricity has taken the place of oil in drilling operation.

Looks Ahead for Navy

"The San Joaquin Light and Power Corporation has more demands for electric motors in the oil fields, for pumping, than it can supply; so has the California Edison Co.—and in spite of the tremendous amount of navy oil reserve held by the United States government, Secretary Daniels has just made a complete study of the Alaskan coal fields in order that coal may be used to conserve oil in the navy, wherever possible—this because the United States government realizes very thoroughly that the safety of the nation depends upon the conservation of the oil within our own borders.

"The Geological Survey has continuously been emphatic in its warnings as to the oil situation; the United States Navy Department has assigned officers to the study of production and manufacture of oil and its products, and the Interdepartmental Board, composed of representatives of all of the government agencies in Washington, has aroused the nation in regard to the international oil situation. The government has even gone so far as to attempt the authorization of a national production company which will protect the United States in foreign fields. Owners of oil lands—not the producing companies—realizing the situation and the trend of future prices, are withholding their lands from development in order to reap the higher prices that must come. This is not an unmixed evil, because the very withholding of these oil lands from development prolongs the life of our oil supply."



Electric Generator Troubles

How They May Be Detected and How Overcome

WHEN a generator fails to produce current, the cause can usually be traced to the inability of a self excited unit to build up its field. To start such a unit properly, a certain amount of field residual magnetism is required which must be increased to full strength by the current generated in the machine itself. This trouble is not likely to occur in a separately excited unit and if it does, it is usually due to the failure of the exciter.

The cause of this condition is weak or destroyed residual magnetism, due to vibration or jar, proximity of another unit, a strong current through the armature when there is little or no field current, which tends to neutralize or reverse the field owing to the reverse ampere turns, and accidentally reversed current through shunt or series field coils which may not be enough to reverse the magnetism completely. Reversal of magnetism will not cause failure to generate. The symptom of this ailment is weak or no attraction when the pole pieces are touched with a piece of iron.

To relieve the condition, send a magnetizing current from another machine through the field coils, then start the generator again. If this fails, change the direction of the exciting current since it may have enough polarity to prevent them building up in the case. Shifting the brushes backward will make the armature magnetism assist that of the field. Change the polarity of the machine so that influence of adjacent machines will have the opposite effect.

Another cause to be reckoned with is reversed connections or reversed rotation. An indication of this condition is the fact that while running the pole pieces will not attract a piece of iron. The application of external excitation will not, in this case, make the machine generate because whatever field is built up is destroyed by the armature current.

The remedy is to reverse either the field or armature connections, to move the brushes through 180 deg. for two-pole, 90 deg. for four-pole, 60 deg. for six-pole, etc., or to reverse the direction of rotation. After any of the above alterations, the field will have to be excited from an outside source.

Another cause in short-circuiting of either the internal or external circuit which manifests itself in weak magnetism.

If the short is in the external circuit, it will prevent a shunt dynamo from building its field; but with a series machine the building up of the field will be hastened. If the short is in the machine, it will likely prevent the building up of either type. A slight short such as a defective socket or copper dust on the commutator may prevent a shunt machine from building up as will also an overload.

Field coils opposed to each other is still another cause of failure to generate. The evidence of this condition is the appearance, when tested with a compass, of similar poles adjacent to each other. This state of affairs can be corrected by reversing the connections on the reversed poles.

An open circuit which may be caused by a broken wire or faulty connection in machine, brushes not in contact, safety fuse being blown or circuit breaker being out, or an open switch will quite naturally cause failure to generate.

If the trouble is an external open circuit, the field of a shunt machine will be fully magnetized and the machine will be working perfectly; but if the trouble is inside the machine, the field will be weak. A break in the field circuit of a separately excited installation will prevent generation and is indicated by no field in the generator and full exciter field.

A break in a single-phase series-wound armature will result in non-generation, in a two or three-phase "Y" armature will cause it to generate single-phase, while in a delta armature it continues to give three-phase but at reduced capacity.

To remedy, make a careful inspection for open circuit in both field coils and armature. A break or excessive resistance in the shunt field or field regulator will also make the magnetism weak. This may be detected by cutting out the rheostat for an instant or by connecting the two terminals of the field coils to the brushes in first one and then the other direction.

A high resistance in the circuit of a series-wound machine will prevent building up. Short the machine momentarily to start the field.

Failure to generate may also be caused by the brushes being improperly placed. The tell-tale of this condition is a change in the magnetism and voltage when the brushes are shifted.

It frequently happens that the brushes are not set at the correct point or they may be set at exactly the wrong position, in which case the machine is incapable of delivering any current whatever. This trouble is probably due to the fact that no two machines have the same setting. Drawings should be obtained showing

the proper position of the brushes before an attempt is made to set them.

Sparking at Commutator

Sparking at the commutator is a common trouble. One cause of this is excessive armature current, due to an overload on the machine, short circuit, ground or excessively high voltage.

To remedy, reduce the load, eliminate the short circuit or ground, or reduce the voltage.

Brushes not set at the neutral point may cause excessive sparking. In this case, the sparking will vary when the brushes are shifted. The brushes should be shifted until the trouble disappears. Care should be taken to see that the brushes are exactly opposite.

A commutator rough, eccentric or with high bars will cause sparking, due to imperfect contact of the brushes. A rough commutator should be filed or stoned down, or even taken out and turned if extremely bad. Eccentricity may be in the armature or merely due to a loose bearing. If the former, it should be turned down; if the latter, new bearings should be fitted.

In order that the commutator should wear smooth, the shaft should be allowed end play of about ⅛ in.

Other causes of poor conductivity at the brushes are dirty or oily brushes, a glass hard brush which is incapable of wearing to a good seat, or a brush that has a high specific resistance.

The remedy is to clear the fouled parts and replace poor brushes.

A short-circuited or reversed coil in the armature will cause sparking, which condition can be noticed by the excessive power required to run the generator without load. The short-circuited coil heats faster than the others and is likely to burn out unless promptly attended to. A piece of steel held between the pole pieces near the armature will vibrate as the defective coil passes.

Such a short is often caused by a piece of solder or other metal getting in between the commutator bars or their connections. The trouble is easily found and remedied. If, however, the short is in the coil itself, the only reliable repair is to rewind the coil.

A broken armature circuit will cause violent flashing and the bar nearest the break will be badly burned. A poor contact somewhere in the circuit will have this same effect to a lesser degree.

Such a break or poor contact may be located by the drop of potential or continuity test. The break is usually in the connections between the coil and bar where it can be readily repaired. If it is in the coil, the only remedy is to rewind the troublesome part.

A ground in the armature will often cause sparking. When two or more grounds occur in the armature the result is a short circuit and the case should be so treated. A single ground on electric railway line or a three-wire system with the neutral wire grounded will have the same effect.

To find the ground, wrap a flexible conductor around the commutator. Apply a current through this connection and the shaft. If a ground is present, a current will flow and the defective coil will be energized. It can then be located with a compass.

A weak magnetic field causes sparking. The telltale of this condition is weak pole pieces and the point of least sparking is shifted considerably from the normal position. Full voltage or current is not forthcoming.

The causes of this condition are (1) a broken circuit which may be found by opening the field circuit after having insulated the field; if no spark occurs, there is a break some place in the circuit; (2) short circuit; (3) grounding, which may be found by the drop-in-potential method.

A broken circuit is easily repaired if accessible; if it is in the coil, the coil will have to be rewound. If the circuit voltage is low, sparking will result. If it cannot be raised, the field resistance should be reduced by unwinding a few layers of wire.

Flashing Over

Flashing over is a spark jumping from one set of brush holders to another or to the frame. This is caused by poor or insufficient insulation between the points mentioned or by deposits of copper or carbon dust on the surface of the insulation. This latter is the usual cause and the trouble can be eliminated by simply cleaning the parts with an oily cloth.

Ring fire is an exaggerated case of commutator sparking and may cause flashing over from one set of brushes to the next. The remedies for commutator sparking will obviously do away with this trouble.

Heating of Parts

Any of the causes of sparking will cause heating of the commutator. In fact, heating frequently occurs from these causes before sparking is noticeable.

The next in importance is heat spreading from other parts of the machine. The machine should be started when cool and run for a few minutes, then a search made for warm parts before the heat has had a chance to radiate to the rest of the machine.

These parts should be attended to as directed under their respective headings.

An overheated commutator will cause deterioration of the brushes and cover it with a black film which offers more resistance and aggravates the trouble. The commutator should be cleaned and different brushes fitted if necessary.

Brush connections may offer abnormally high resistance which may be tested by the drop of potential method and improved.

Heating will occur when there is an arc or short circuit between bars or between bars and end ring. The arc will be noticeable when the machine is running. Burnt or otherwise defective insulation should be taken out and replaced.

Brushes of high specific resistance will produce heat. Better carbons of greater conductivity should be installed.

The friction of the brushes will also produce heat. This case can be differentiated from the preceding one by noting whether or not the temperature is excessive when the current is light. This may be due to heavy pressure or high speed. Reduce the spring tension. Decrease speed, but keep up the voltage by increasing the field. Lubricate slightly with oil or vaseline.

Excessive current will cause heating of the armature as will also moisture in the coils. Moisture can be detected by steaming when hot. The armature should be

taken out and baked for several hours at a temperature sufficiently high to drive out the moisture, but not hot enough to injure the insulation.

When the iron of the armature core is found to be warmer than the coils after a short run, and when considerable power is required to turn the armature when there is no current through it and when the field is connected, indications are that there are eddy currents in the core. This is a question of poor lamination and a matter of primary construction.

Reversed coils in one part of an armature will cause local currents to circulate around a direct-current armature, causing a rise in temperature. This will mean excessive power to drive a generator without load. A compass will indicate the reversed coil when a current is sent through each coil separately. The remedy lies in simply reconnecting the terminals to agree with the rest.

Excessive current in the field circuit will bring about heating of the field magnets. A temperature of 122 deg. F. above room, as determined by a resistance test, is considered high.

In the case of a shunt wound or separately excited machine, decrease the field voltage or increase the resistance. In the case of series winding, shunt a portion of the current. This condition might be caused by a short circuit, in which case the defective coil will be cooler than the others. As a check, measure the resistance of each coil; if there is any considerable variation, the low resistance coil is sure to be grounded or short-circuited.

In alternating or pulsating current work, the field pieces will become heated due to eddy currents unless they are carefully laminated.

Moisture in these coils will cause short-circuiting and heating, as in the armature.

Heating of bearings is a condition to which any machine not properly constructed or attended to, is subject. In cases where a stop for repairs would be fatal, temporary relief may be had by pouring cold water on the bearing or packing it in ice.

This state of affairs is usually due to lack of oil. The oil passages may be clogged, the reservoir dry, the oiling devices out of order. These defects should, of course, be remedied. Use good oil. It will be money well invested.

Grit in the bearings will cause heating. Remove the bearing and investigate for foreign particles. Scratches will be noticed. Remove the dirt, clean the bearing, use clean oil and provide a dirt-proof casing if necessary.

A shaft that is rough, scored, or too large will also cause heating. It should be turned down in a lathe and refitted.

A sprung shaft presents difficulties in truing and a new one is usually necessary.

A shaft turns hard and heats when the bearings are out of line. Conditions are relieved by loosening the holding bolts. Bolt the bearings in a position where the shaft turns freely, being sure that the armature is in the center of the field.

Thrust of a shoulder or the shaft against the bearings will generate heat and is caused by the belt drive being out of line or by the armature not being centered axially with the field coils. The remedy will be found in lining up the belt or moving the collar to allow the shaft to center itself.

Too heavy tension on the belt or eccentricity of the armature will cause an extra load on one side of the bearing and heating of the bearing which will wear elliptical in time and aggravate the trouble due to an eccentric armature. The belt tension should be decreased, using a larger pulley if necessary, and the armature should be centered. If the bearings have worn elliptical, new ones should be fitted.

Noisy Operation

The most frequent source of noise is the humming, squeaking or hissing of the brushes on the commutator. This trouble can readily be located by the ear. File or dress the brushes down with sandpaper and apply a little oil or vaseline. Changing the length of the brushes and the pressure often helps.

Vibration due to the revolving armature, field, pulley or commutator being out of balance is, of course, objectionable. The parts should be taken out and balanced, separately, because a static balance of the whole combination is not likely to prove to be a dynamic one. A dynamic balance takes place only when equal moments are directly opposed to each other.

When the armature rubs against the pole pieces, noise results. Bind down any abnormal projection on the armature; center the armature; chip off high spots on the field pieces.

Noise caused by the collar or pulley rubbing on the bearing is due to the same condition that causes bearings to heat, and should be so treated.

Rattling due to the looseness of parts can be eliminated by careful inspection of the machine before or after each run. Tighten up the loose parts. Replace a poorly fitting bearing.

The flapping of a belt joint on the pulley produces a disagreeable sound which should be stopped by making a better joint.

An intermittent squeaking sound which indicates a slipping belt may be overcome by increasing the tension of the belt or by applying a belt dressing.

The humming of the armature core teeth as they pass the pole pieces ought not to occur if the machine is properly constructed. It can be relieved by sloping the edges of the pole pieces.

Humming due to alternating current is inherent to a large extent in alternators, but can be deadened by mounting the machines on felt or some such material.

Improper Voltage

This is a common difficulty which may arise in any machine and is due to the following causes: Field magnetism too strong or too weak; brushes not in proper position; generator overloaded; short-circuited or reversed armature coils.

All of these produce sparking and are dealt with under that head.

Speed too high or too low, or open, short-circuited or reversed field coils may prevent a dynamo from generating current.

A direct or alternating-current generator, unless it is compound or composite wound, tends to fall in voltage with increased load. This is usually overcome by raising the field current or by cutting out field resistance.

First Electrically Operated Merchant Vessel in U. S.

S. S. Eclipse Equipped with Turbine; Electric Drive by Induction Motor. By B. S. Beach

THE S. S. ECLIPSE, the first electrically driven general cargo merchant vessel in the United States, was placed in service in Jersey City, N. J, last month. The "Eclipse," Fig. 1, is also the first electrically propelled vessel owned by the United States Shipping Board and is under charter to the American Line of the International Mercantile Marine.

She is a vessel of 11,868 dead weight tonnage, 440 ft. long, and with beam of 56 ft. The boat was built by the Union Iron Works of San Francisco, and has present electric propulsion machinery manufactured by the General Electric Company, and installed by the Vulcan Iron Works.

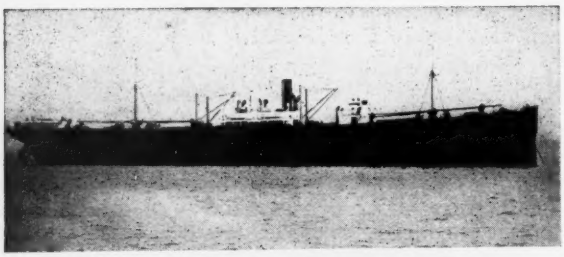


FIG. 1. ELECTRICALLY PROPELLED S. S. ECLIPSE

Her propulsion machinery consists of a marine turbine generator set and a three-phase induction motor which drives the single propeller shaft at 100 r.p.m. There are also two steam engine-driven 125-v. d.c. exciters and a control equipment for maneuvering the ship.

Generating Set

THE TURBINE is of the horizontal Curtis marine type, Fig. 2, operating normally at 3000 r.p.m. and so arranged that the turbine is controlled by a hydraulic variable speed governor at speeds from 20 to 110 per cent of normal. It is further provided with protective devices in the way of a centrifugal type pre-emergency governor controlling the speed up to 115 per cent of normal and a ring type emergency governor which prevents the turbine from running at speeds exceeding 125 per cent of normal.

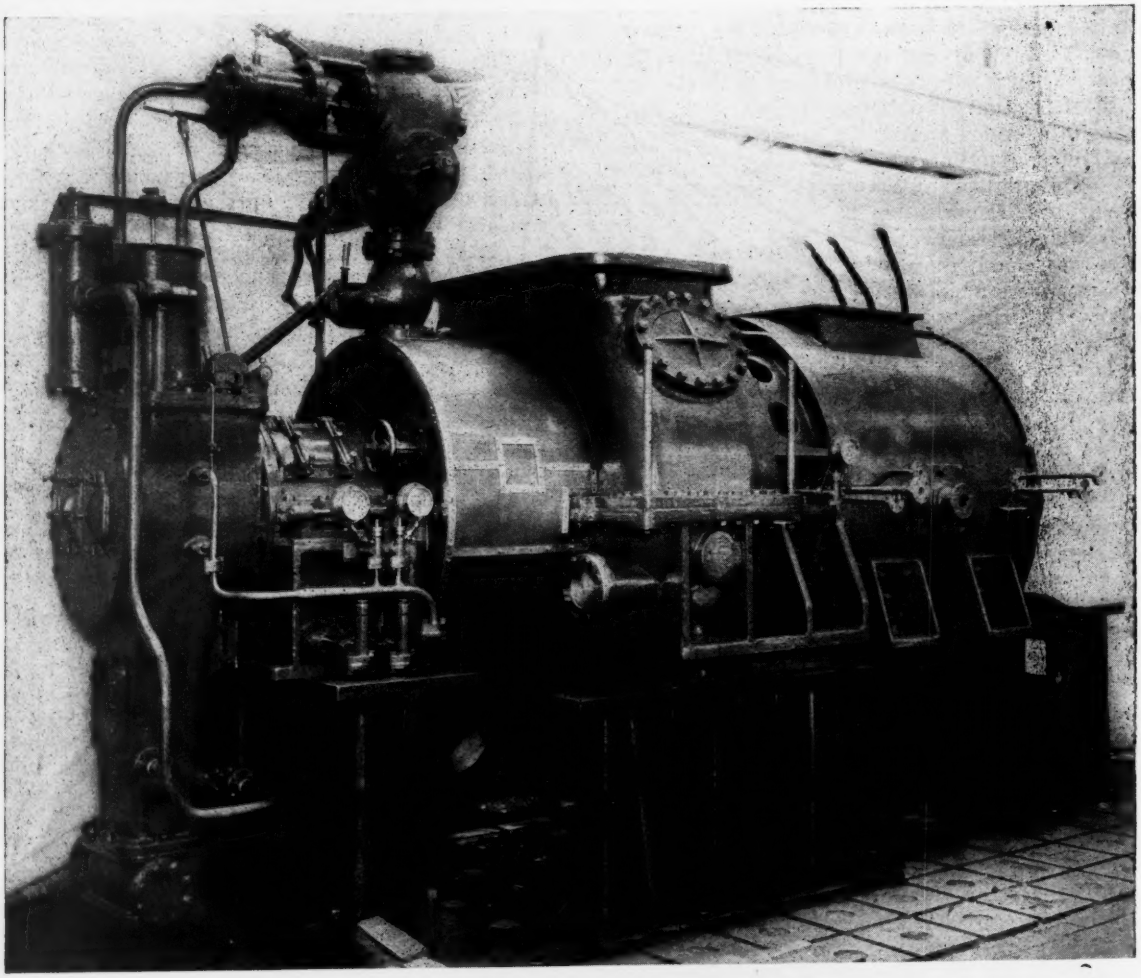


FIG. 2. TURBINE GENERATOR SET, PORT SIDE, LOOKING AFT

The three-phase generator of 2300 v., especially designed for marine service, incorporates several features necessary to meet the particular requirements of the class of work which it is called upon to do. The stator consists of a cast-iron, one-piece frame with openings in the top for ventilation, which is provided by a centrifugal fan mounted at each end of the rotor. The core is built up of annealed segments of thin sheet iron of special material to insure low core loss and is held in place by heavy cast-iron frame flanges at each end.

Windings are formed coils pressed from enameled cable, each turn consisting of rectangular copper strips in multiple. Eddy currents are eliminated by the strips being well insulated from each other.

Motor

THE PROPELLER is driven by an induction motor rated at 3000 hp. and revolving at a normal speed of 100 r.p.m., which gives a total reduction from turbine speed to propeller speed of 30 to 1. The motor is ventilated by a motor-driven blower. The construction of the motor stator is similar to the generator stator. The rotor consists of a cast-iron spider keyed to the shaft on which the rotor core is assembled, with windings of insulated copper bars.

Control Equipment

CONTROL EQUIPMENT consists of a control group, a water cooled resistor, and a control panel, indicated in Fig. 3. The water cooled resistor, which is mounted on top of the control panel, is inserted in the motor circuit when operating the motor at low speeds. The panel, Fig. 4, is a structural iron cell faced on one side by a sheet steel plate upon which are mounted all the electrical instruments and the electric and speed levers for normal operation of the machinery, the two levers being mechanically interlocked, to prevent improper starting and running conditions. The electric lever moves the master controller which in turn energizes the contactors of the control group, normally operated by solenoids.

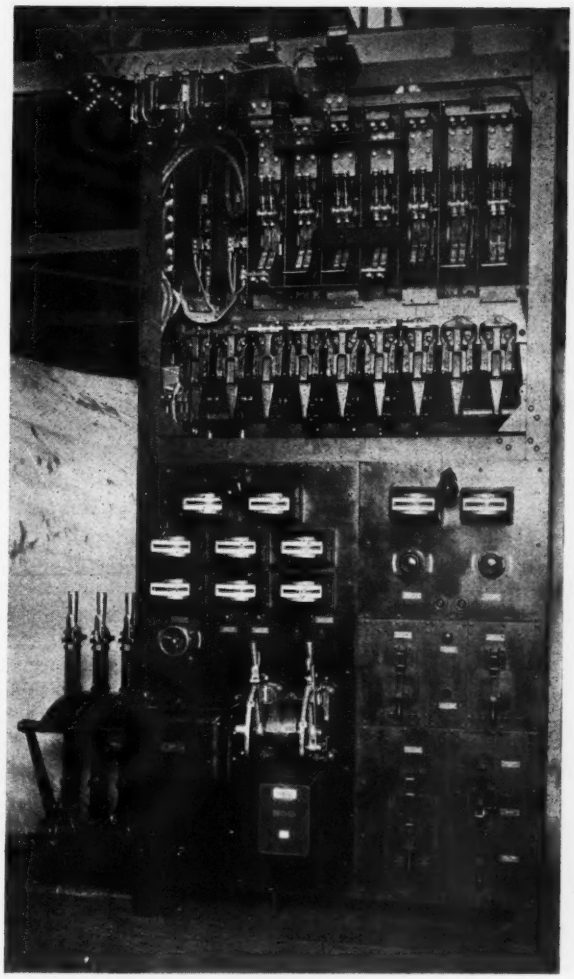


FIG. 4. FRONT OF CONTROL PANEL FOR ELECTRICAL SHIP PROPULSION

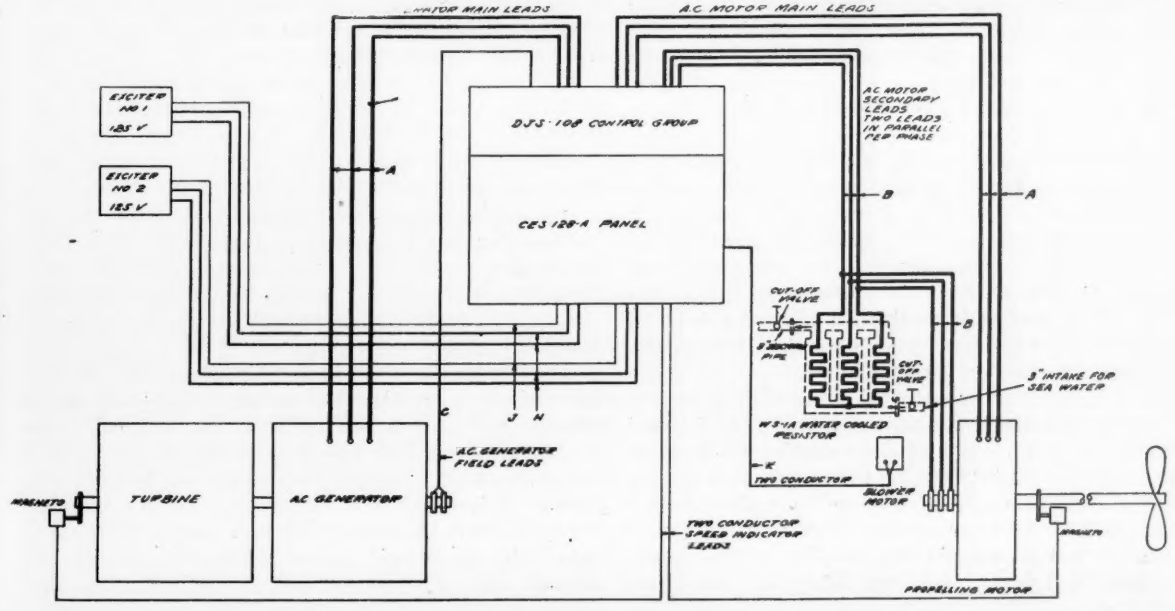


FIG. 3. DIAGRAM OF ELECTRICAL CONTROL SYSTEM FOR S. S. ECLIPSE

In addition to the speed and electric levers there is a field resistor for regulating the generator field resistance and an auxiliary handle for operating a fused disconnecting switch in the control circuit leading from the 125-v. power supply to the master controller. There are also levers for connecting either exciter into circuit, two exciter resistors, one for each exciter, and levers for connecting the blower, and generator field to the exciter bus.

If for any reason it became necessary or desirable to operate the control group manually, this could be accomplished by means of three levers mounted to the left side of the control panel. These levers are from left to right the resistor lever, the field lever, and the reverse lever. These levers actuate the contactors directly by means of cams. This method of operation might become necessary by the burning out of the contactors.

An Invention that Brought the World Together---I

ANCESTRY, EARLY LIFE AND EXPERIMENTS OF ALEXANDER GRAHAM BELL. BY F. H. SWEET

NOT long ago, I was talking with Henry Pettit, writer, musician, traveler and other things, at Palm Beach. Mr. Pettit was in charge of the Centennial Exhibition at Philadelphia, in 1876, of the American interests at the Paris Exposition, and first brought Sousa before the public at a mechanics fair at Washington.

Mr. Pettit said that the most remarkable thing at Philadelphia was the first demonstration of the Bell telephone. A wire was stretched from one corner of the Main Building diagonally across to the opposite far corner. The receivers were mere boxes of pasteboard. William Thomson, afterward Lord Kelvin, the English scientist, was there. When mention was made of the new telephone and what it could do, he ridiculed it as another "Yankee trick," of which he had already seen many. With considerable difficulty, he was induced to station himself at one end of the wire, with a pasteboard box to his ear. He heard low words passed over the wire, which could be heard in no other way.

But even then he would not believe. It was only when he placed his wife at the other end, and heard her talk, that he knew. Then he became transformed, studied the wonderful discovery for some minutes, then sat down at a table and drew some suggestive improvements.

A year before this, when the Atlantic Cable and the telegraph were the most wonderful things in the world, a tall young professor of elocution was desperately busy in a noisy machine-shop that stood in one of the narrow streets of Boston, not far from Scollay Square. It was a very hot afternoon in June, but the young professor had forgotten the heat and the grime of the workshop. He was wholly absorbed in the making of a nondescript machine, a sort of crude harmonica with a clock-spring reed, a magnet, and a wire. It was a most absurd toy in appearance. It was unlike any other thing that had ever been made in any country. The young professor had been toiling over it for three years, and it had constantly baffled him, until, on this hot afternoon in June, 1875, he heard an almost inaudible sound, a faint twang, come from the machine itself.

For an instant he was stunned. He had been expecting just such a sound for several months, but it came so suddenly as to give him the sensation of surprise. His eyes blazed with delight, and he sprang in a passion of eagerness to an adjoining room in which stood a young mechanic who was assisting him.

"Snap that reed again, Watson," cried the apparently irrational young professor. There was one of the odd-looking machines in each room, so it appears, and the two were connected by an electric wire. Watson had snapped the reed on one of the machines and the professor had heard from the other machine exactly the same sound. It was no more than the gentle twang of a clock-spring; but it was the first time in the history of the world that a complete sound had been carried along a wire, reproduced perfectly at the other end, and heard by an expert in acoustics.

The twang of the clock-spring was the first tiny cry of the new-born telephone, uttered in the clanging din of a machine-shop and happily heard by a man whose ear had been trained to recognize the strange voice of the little newcomer. There, amidst flying belts and jarring wheels, the baby telephone was born, as feeble and helpless as any other baby, and "with no language but a cry."

The professor-inventor, who had thus rescued the tiny foundling of science, was a young Scottish-American. His name, now known as widely as the telephone itself, was Alexander Graham Bell. He was a teacher of acoustics and a student of electricity, possibly the only man in his generation who was able to focus a knowledge of both subjects upon the problem of the telephone. To other men that exceedingly faint sound would have been as inaudible as silence itself, but to Bell it was a thunder-clap; it was a dream come true; it was an impossible thing which had in flesh become so easy that he could scarcely believe. Here, without the use of a battery, with no more electric current than that made by a couple of magnets, all the waves of a sound had been carried along a wire and changed back to sound at the farther end. It was absurd; it was incredible; it was something which neither wire nor electricity had been known to do before; but it was true.

No discovery has ever been less accidental. It was the last link of a long chain of discoveries. It was the result of a persistent and deliberate search. Already, for half a year or longer, he had known the correct theory of the telephone; but he had not realized that the feeble undulatory current generated by a magnet was strong enough for the transmission of speech. He had been taught to undervalue the incredible efficiency of electricity.

Not only was Bell himself a teacher of the laws of speech, so highly skilled that he was an instructor in Boston University. His father, too, his two brothers, his uncle, and his grandfather had taught the laws of speech in the universities of Edinburgh, Dublin and London. For three generations, the Bells had been professors of the science of talking. They had even helped

to create that science by several inventions. The first of them, Alexander Bell, had invented a system for the correction of stammering and similar defects of speech. The second, Alexander Melville Bell, was the dean of British elocutionists, a man of creative brain and a most impressive facility of rhetoric. He was the author of a dozen text-books on the art of speaking correctly, and also of a most ingenious sign-language which he called "Visible Speech." Every letter in the alphabet of this language represented a certain action of the lips and tongue; so that a new method was provided for those who wished to learn foreign languages or to speak their own language more correctly. And the third of these speech-improving Bells, the inventor of the telephone, inherited the peculiar genius of his fathers, both inventive and rhetorical, to such a degree that as a boy he had constructed an artificial skull, from gutta-percha and india-rubber, which, when enlivened by a blast of air from a hand-bellows, would actually pronounce several words in an almost human manner.

The third Bell, the only one of the remarkable family who concerns us at this time, was a young man, barely twenty-eight, at the time when his ear caught the first cry of the telephone. But he was already a man of some note on his own account. He had been educated in Edinburgh, the city of his birth, and in London; and had in one way and another picked up a smattering of anatomy, music, electricity, and telegraphy. Until he was sixteen years of age, he had read nothing but novels and poetry and romantic tales of Scottish heroes. Then he had left home to become a teacher of elocution in various British schools, and by the time he was of age he had made several slight discoveries as to the nature of vowel-sounds. Shortly afterward, he met in London two distinguished men, Alexander J. Ellis and Sir Charles Wheatstone, who did far more than they ever knew to forward Bell in the direction of the telephone.

Ellis was president of the London Philological Society. Also, he was the translator of the famous book on "The Sensations of the Tone," written by Helmholtz, who, in the period from 1871 to 1894 made Berlin the world-center for the study of the physical sciences. So it happened that when Bell ran into Ellis as a young enthusiast and told his experiments, Ellis informed him that Helmholtz had done the same things several years before and done them more completely. He brought Bell to his house and showed him what Helmholtz had done—how he had kept tuning-forks in vibration by the power of electro-magnets, and blended the tones of several tuning-forks together to produce the complex quality of the human voice.

Now, Helmholtz had not been trying to invent a telephone, nor any sort of message-carrier. His aim was to point out the physical basis of music, and nothing more. But this fact that an electro-magnet would set a tuning-fork humming was new to Bell and very attractive. It appealed at once to him as a student of speech. If a tuning-fork could be made to sing by a magnet, why would it not be possible to make a musical telegraph—a telegraph with a piano keyboard, so that many messages could be sent at once over a single wire? Unknown to Bell, there were several dozen inventors then at work on this problem, which proved in the end to be very elusive. But it gave him at least a starting-point, and he forthwith commenced his quest of the telephone.

As he was then in England, his first step, naturally, was to visit Sir Charles Wheatstone, the best known English expert on telegraph. Sir Charles has earned his title by many inventions. He was a simple, natural scientist, and treated Bell with the utmost kindness. He showed him an ingenious talking-machine that had been made by Baron de Kempelin. At this time Bell was twenty-two and unknown; Wheatstone was sixty-seven and famous. And the personality of the veteran scientist made so vivid a picture upon the mind of the impressionable young Bell that the grand passion of the science became henceforth the master-motif of his life.

From this summit of glorious ambition he was thrown, several months later, into the depths of grief and despondency. The White Plague had come to the home in Edinburgh and taken away his two brothers. More, it had put its mark upon the young inventor himself. Nothing but a change of climate, said his doctor, would put him out of danger. And so, to save his life, he and his father and mother set sail from Glasgow and came to the small Canadian town of Brantford, where for a year he fought down his tendency to consumption, and satisfied his nervous energy by teaching "Visible Speech" to a tribe of Mohawk Indians.

By this time it had become evident, both to his parents and friends, that young Graham was destined to become some sort of creative genius. He was tall and supple, with a pale complexion, large nose, full lips, jet-black eyes, and jet-black hair, brushed high and usually rumpled into a curly tangle. In temperament he was a true scientific Bohemian, with the ideals of a savant and the disposition of an artist. He was wholly a man of enthusiasms, more devoted to ideas than to people; and less likely to master his own thoughts than to be mastered by them. He had no shrewdness, in a commercial sense, and very little knowledge of the small practical details of ordinary living. He was always intense, always absorbed. When he applied his mind to a problem, it became at once an enthralling arena, in which went whirling a chariot-race of ideas and inventive fancies.

He had been fascinated from boyhood by his father's system of "Visible Speech." He knew it so well that he once astonished a professor of Oriental languages by repeating correctly a sentence of Sanscrit that had been written in "Visible Speech" characters. While he had been living in London, his most absorbing enthusiasm had been the instruction of a class of deaf-mutes, who could be trained to talk, he believed, by means of the "Visible Speech" alphabet. He was so deeply impressed by the progress made by these pupils, and by the pathos of their dumbness, that when he arrived in Canada he was in a dilemma as to which of these two tasks was the most important—the teaching of deaf-mutes or the invention of a musical telegraph.

At this point, and before Bell had begun to experiment with his telegraph, the scene of the story shifts from Canada to Massachusetts. It appears that his father, while lecturing in Boston, had mentioned Graham's exploits with a class of deaf-mutes; and soon afterward the Boston Board of Education wrote to Graham, offering him $500 if he would come to Boston

and introduce his system of teaching in a school for deaf-mutes that had been recently opened. The young man joyfully agreed, and on the first of April, 1871, crossed the line and became for the remainder of his life an American.

For the next two years, his telegraphic work was laid aside, if not forgotten. His success as a teacher of deaf-mutes was sudden and overwhelming. It was the educational sensation of 1871. It won him a professorship in Boston University; and brought so many pupils around him that he ventured to open an ambitious "School of Vocal Physiology," which at once became a profitable enterprise. For a time, there seemed to be little hope of his escaping from the burden of his success and becoming an inventor, when, by a most happy coincidence, two of his pupils brought to him exactly the sort of stimulation and practical help that he needed and had not up to this time received.

One of these pupils was a little deaf-mute tot, five years of age, named Georgie Sanders. Bell had agreed to give him a series of private lessons for $350 a year; and as the child lived with his grandmother in the city of Salem, 16 mi. from Boston, it was agreed that Bell should make his home with the Sanders family. Here he found not only the keenest interest and sympathy in his air-castles of invention, but also was given permission to use the cellar of the house as his workshop.

For the next 3 yr., this cellar was his favorite retreat. He littered it with tuning-forks, magnets, batteries, coils of wire, tin trumpets, and cigar-boxes. No one outside of the Sanders family was allowed to enter it, as Bell was nervously afraid of having his ideas stolen. He would even go to five or six stores to buy his supplies, for fear that his intentions would be discovered. Almost with the secrecy of a conspirator, he worked alone in this cellar, usually at night, and quite oblivious of the fact that sleep was a necessity to him and to the Sanders family.

"Often in the middle of the night Bell would wake me up," said Thomas Sanders, the father of Georgie. "His black eyes would be blazing with excitement. Leaving me to go down to the cellar, he would rush wildly to the barn and begin to send me signals along his experimental wires. If I noticed any improvement in his machine, he would be delighted. He would leap and whirl around in one of his 'war-dances' and then go contentedly to bed; but if the experiment was a failure, he would go back to his work-bench and try some different plan."

The second pupil who became a factor—a very considerable factor—in Bell's career, was a fifteen-year-old girl, named Mabel Hubbard, who had lost her hearing, and consequently her speech, through an attack of scarlet-fever when a baby. She was a gentle and lovable girl, and Bell, in his ardent and headlong way, lost his heart to her completely; and four years later, he had the happiness of making her his wife. Mabel Hubbard did much to encourage Bell. She followed each step of his progress with the keenest interest. She wrote his letters and copied his patents. She cheered him on when he felt himself beaten. Through her sympathy with Bell and his ambition, she led her father—a widely known lawyer named Gardiner G. Hubbard—to become Bell's chief spokesman and defender, a true apostle of the telephone.

Hubbard first became aware of Bell's inventive efforts one evening when Bell was visiting at his house in Cambridge. Bell was illustrating some of the mysteries of acoustics by the aid of a piano. "Do you know," he said to Hubbard, "that if I sing the note G close to the strings of the piano, the G-string will answer me?"

"Well, what then?" asked Hubbard.

"It's a fact of tremendous importance," replied Bell. "It is an evidence that we may some day have a musical telegraph, which will send as many messages simultaneously over one wire as there are notes on that piano."

"Later, Bell ventured to confide to Hubbard his wild dream of sending speech over an electric wire, but Hubbard laughed him to scorn. "Now you are talking nonsense," he said. "Such a thing never could be more than a scientific toy. You had better throw that idea out of your mind and go ahead with your musical telegraph, which, if it is successful, will make you a millionaire."

But the longer Bell toiled at his musical telegraph, the more he dreamed of replacing the telegraph and its cumbrous sign-language by a new machine that would carry, not dots and dashes, but the human voice. "If I can make a deaf-mute talk," he said, "I can make iron talk." For months he wavered between the two ideas. He had no more than the most hazy conception of what this voice-carrying machine would be like. At first he conceived of having a harp at one end of the wire, and a speaking-trumpet at the other, so that the tones of the voice would be reproduced by the strings of the harp.

Then, in the early summer of 1874, while he was puzzling over this harp apparatus, the dim outline of a new plan suddenly glinted in front of him.

(To be continued.)

THE CENTRAL MAINE POWER CO. is now making several line extensions and is bending every effort to finish these lines before winter sets in.

The high tension line from Farmingdale to Lewiston, a distance of 30 mi., was built in a month. A new high tension line from Waterville to Skowhegan and still another from Skowhegan to Guilford are being built at the present time. These are important links in the company's interconnected system.

A new service line from South Paris to West Paris and Paris, a distance of 10½ mi., is partially completed.

Another service line, "tapped" onto the Farmingdale-Lewiston high tension line at Wales Crossing, has been put through to Wales, Leeds Junction and Monmouth.

From Lewiston another service line is being started to the town of Greene and will be in operation shortly.

U. S. CIVIL SERVICE COMMISSION announces an examination (receipt of applications to close Dec. 7, 1920) for electrical engineer and draftsman, to fill vacancies in the office of the Supervising Architect, Treasury Department, Washington, D. C., at $1800 a year, and in positions requiring similar qualifications, at this or higher or lower salaries. Appointees whose services are satisfactory may be allowed the increase granted by Congress of $20 a month.

Unusual Lubrication

By C. E. Anderson.

DURING this past summer, I have had numerous experiences with small refrigerating machines, which might be of interest to readers.

A letter came one day in the early part of the summer from a confectionery store in Ohio, stating that they could not run their refrigerating plant, and wanted a man to come and fix it at once.

I called the proprietor of this store on the long distance 'phone and inquired what the trouble was, as his letter did not give any reason why they could not operate the plant. He answered that the compressor would not turn over. They had tried to turn it over with bars on the flywheel spokes, but could not budge the machine.

I arrived at the plant as soon as possible. In going to the plant, I tried to diagnose the trouble and felt reasonably sure that they had operated the machine wihout a sufficient amount of oil in the crankcase, and that the pistons had run hot and froze to the cylinder walls. This is a very common occurrence.

The machine in question was of the vertical enclosed crankcase, high-speed type of 5 t. capacity. On arriving at the plant, I tried to gather as much information as I could regarding the trouble. The machine had been acting rather peculiarly for several days, I was told, and on the last day that the machine was operating they had great difficulty in keeping it going, as the motor continually blew out the fuses. It blew all the fuses they had and then some "wise guy" told them to use hay wire instead of fuses and they would have no more trouble. This advice they followed, with the result that the main fuses at the transformer, outside on a pole, were blown out. This put the whole establishment out of commission until the electric light company was notified and their trouble man replaced the blown fuses. All this, of course, took some time. When they had power again, they tried to run the compressor and found that they could not turn it over.

I looked at the oil gage on the crankcase of the machine and it seemed full, at least the glass was black its full length. I began to doubt my diagnosis on the train. The cylinder heads were removed, in order to look at the cylinder walls and pistons. On removing the cylinder heads, I found the discharge valve and chambers choked up with a gluey, gummy mass, having a peculiar sweet smell. Never before had I seen oil look like that, and I suspected right away that something besides oil had been pumped into the crankcase. The crankcase cover was the next thing to come off, and we found the crankcase one solid mass of this gluey, gummy stuff, with a few hard lumps in it about the size of an egg.

I showed all this to the proprietor, and asked him what kind of oil he was using. He showed me a barrel in one corner of the basement that he had purchased only three weeks before. This barrel proved to be a well-known brand of zero oil and was O.K., but the barrel had never been tapped. This fact I brought to his attention. He sent upstairs for a young fellow who operated the plant and questioned him about the machine, especially about the oil he used in the crankcase. He replied that when he was hired (about the same time the oil came) he was told to keep the oil about in the middle of the oil gage glass and to use the oil out of a red barrel. This he claimed he had done at all times. He was next asked how he got oil out of the barrel, when it was not as yet opened. He answered by taking us over to one corner of the basement and showing us a little red barrel (half barrel) standing on a packing case, with a spigot on it. This is the oil he used, just as he was told to do. He opened the spigot and drew off some of this oil. It smelled sweet, just like the stuff in the crankcase. I lit a match, as it was rather dim, in order to read the label on the head of the barrel. It was a nicely designed label and it read, "This half barrel contains 16 gal. Coca-Cola Syrup."

He used the oil out of the red barrel all right, but it was the wrong barrel. We knew now what we had in the crankcase. The next question was to get all that stuff out of the compressor, pipe work and condenser. I felt reasonably sure some of it had been pumped over into the condenser, because when I opened the drain valve on the oil trap, between the compressor and condenser, I found it plugged up with this stuff.

By means of hot water, streams of cold water from a hose, scrapers, spoons and whatnot, we managed to remove enough of this stuff out of the crankcase, so that I could disconnect the connecting rods from the shaft and pull the pistons out. The whole machine was dismantled and cleaned thoroughly with kerosene and hot water. After the cleaning, we reassembled the compressor and turned her over a few times and found this part of the installation O.K.

The condenser and the pipe connection from the compressor to it were next on the program for cleaning. The condenser was of the double-pipe type, six pipes high and 20 ft. long. The first three pipes of the condenser were the only ones that showed any signs of this gum. These were cleaned and put back in place. We pumped the air out of that part of the system that he had opened for cleaning and started up the plant again.

I stayed around another day to make sure everything was in first class shape and would operate without any further trouble, from that source at least, going home with the firm conviction that you can't lubricate the enclosed type ammonia compressor with Coca-Cola.

Good Insulation Means Economy*

IN DESIGNING a room for the cooling of perishable goods, the owner should consider with the utmost seriousness the kind of insulation material to be placed on the walls, ceiling, and floor, because with good insulation he gets as nearly as possible the full value of his refrigeration machines or his ice in cooling his goods, and does not throw away his money cooling the air and ground in the neighborhood of his plant. Ice and refrigeration cost money continually, but good insulation costs only when it is installed.

Builders of refrigerating machinery, particularly, voice the wisdom of using the best insulation. They know that their machines cannot make a fair record or satisfy the buyer if, in addition to the legitimate and estimated task of refrigeration, they must struggle with unreason-

* Abstract from paper delivered before the Chicago Chapter of the National Association Practical Refrigerating Engineers by W. H. Mihkleson.

able quantities of heat stealing in every minute through poor insulation.

Good insulation results in economies so vast that if the facts are brought home to him, no reasonable man will hesitate to use it. It permits economies everywhere; a smaller refrigerating machine will do the work; less piping is required; in case of accident to the machines, superior insulation will hold the temperatures until repairs can be made, and, by saving valuable stores from injury, may in a single emergency repay entirely its first cost.

The insulating material in a cold storage is just as necessary as the refrigerating machinery. Before it is possible to carry water it is necessary to have a receptacle to hold it. Before it is possible to cool goods, or to lower the temperature of a room, it is necessary to have insulation to prevent the enormous ocean of heat out of doors from flowing into the cooled space as fast as the heat is removed by the refrigerating machinery.

In order to show in a graphic way the saving to be made by good insulation, we will build in our minds in the vicinity of Chicago, two cold storage buildings, each of them 50 ft. long, 25 ft. wide and 20 ft. high. We will ignore the inner division of these buildings into rooms and consider only the difference in them due to insulation, or lack of insulation, on the outside walls, ceilings and floors. The first building is built of 13-in. brick walls with no insulation, and the second is built with 13-in. brick walls and 4 in. of some modern insulation. The ceilings and floors of both buildings are to be constructed of concrete slabs 5 in. thick, and in both instances the floors rest on the ground.

If the interior of these two rooms is held by refrigeration at 30 deg. F., and the outside temperature is assumed to be, for thirty days, 65 deg. F., there will be thrown upon the refrigerating machine in the first building the necessity of removing 92,295,000 heat units which come through the walls, floors and roof during that time, equivalent to 320 tons of refrigeration, which at 50c per ton will cost $160. During the same period and under the same conditions, there will be taken up in the second building by the refrigerating machine 6,378,750 heat units which come through the insulation, equaling 22.1 tons of refrigeration at 50c per ton, or $11.05. Under the conditions described, there will be a net loss to the owner of the brick uninsulated structure of $148.95, in one month, which he could have saved had his building been properly insulated.

Rules and Systems

KEEPING TOOLS AND SUPPLIES IN ORDER FOR IMMEDIATE USE IMPROVES EFFICIENCY. BY E. MATZAN

RULES—regulation—system—red tape—no matter what you call it, introduce the right amount of it into the plant if it is not already there; it means a saving of time, money and temper. Of course we know that the fellows will start grunting over the red tape, but they are grunting ten times more when it is not there; in fact, a man is not completely satisfied if he can not get a little kick in once in a while.

As the old stockkeeper said when I was waiting impatiently for supplies while he carefully coiled a rope, "If I didn't put things in ship-shape as they come along, you would lose a lot more time waiting than you do now and I would lose track of my work." He was mighty right.

When looking for inefficiencies in the plant, the tool-supply is a good place for the start, for worn-out tools might cause a spoiled job.

A pipe-wrench will often be used a year after the jaws are worn out. Tools with renewable parts are always wanted, but are such parts on hand when needed? If pipe-dies wear out so they strip the threads, it might be because engine oil is used on the dies instead of lard oil. Is an oil can that is not leaking a curiosity?

Mechanics who are helping out by using their own tools should have a chance to get worn tools fixed on the house expense.

As far as possible, the duties of keeping the different parts of the plant in trim should be laid out between the watches and the men, so that blame or praise can be placed where they belong.

The main tool locker is generally arranged with a couple of shelves on which the tools are piled up all mixed, leaving a lot of useless empty space between the shelves; sliding trays or shallow drawers could just as well be used and would add much to the capacity of the locker.

At the close of the day the men should be given time to clean up and carry all light tools back to where they belong so that tools not needed can be out of the way next morning.

When the men handling the tools are handled right, they will handle the tools right.

The eight-hour working day is so generally accepted that a man who is made to work more for the same pay feels the injustice of it enough to become unwilling and inefficient; there is not a workingman, skilled or unskilled, who has not enough intelligence to know that he can and will do more and better work in eight hours than in nine or ten, so if the boss who also realizes this insists on keeping his men longer hours, it must be for the purpose of making a show of his ability to drive men; if the work done can not be checked up, he can get away with this, but the firm paying him an exceptional salary for exceptional service pays for the difference in the efficiency of the men.

ARRANGEMENT OF SUPPLIES

A SUPPLY of necessary repair parts should always be kept on hand; in many small plants a regular supply stock is not wanted, but special parts exposed to unusual wear or strain should be ready for use or the result might be a prolonged shut-down with its loss of production.

A supply of bolts, iron, pipe, fittings and other things generally used should be on hand; these must be bought in any case as they are needed and interest on the investment, insurance and other objections commonly

placed against the scheme might be more than counterbalanced by the avoidance of one single shut-down.

The engineer should keep a straight record of everything ordered with prices and all specifications noted.

A card-index record is always efficient; use a card for every article, the card classified and the names or style indicated on protruding tags and arranged in the file in alphabetical sequence. In a file holding a few thousand cards, any one of them can be instantly located by the person using the file.

Arranging the supplies properly so that any article can be found easily is very important.

When the fixtures with their bins are to be built, an estimate should be made of the stock and bins made large enough to suit the stock so that the things will not be mixed; if two sizes or kinds must be placed in one bin, a dividing piece or spacer should be used and besides the regular bin number each space should be sub-numbered.

Each class of supply should have its own fixture or section of fixture and the different styles within each class should be kept together, preferably in vertical rows of bins with the heaviest articles nearest the floor; this arrangement makes it easy for the searcher to see the style he is looking for and looking up or down the vertical row, he will find the size or form wanted.

If the bins in each vertical row can be made of the same width, it will simplify the numbering of the bins. The writer finds that the best way of numbering is to consider only the number of the vertical rows, counting from left to right, and the number of the shelves or bins, counting from top to bottom; the vertical row number should be painted at the top of each row, but the downward bin-numbers need only to be placed on every fourth or fifth row; each fixture should be marked with a letter of the alphabet; an article marked on the stock-card as lying at B-9-3 will this way be found in the ninth vertical row three bins down in fixture B, for there should be a card on file for every article and the card must show the location.

When everything has been put in place and the bins have been numbered, it will serve as a check on the stock-keeper and help out later when inventory is to be taken if a stock-record is put down in a book recording all the bin-numbers with the names and specifications of the goods in the bins, writing down the numbers but leaving space open for specifications where the bins are not yet in use. The office should have this book and only on special permission should the stock-keeper put in a new stock article which the office should then place on the record.

When inventory time draws near the office can make out the stock-sheets with the bin-numbers and names so that all there is left is to count up and put the amount of stock down with the unit price and the office can add up the totals.

In one place, the minimum to be kept on hand is put on the record, the minimum of each article is tied together and a tag carrying all the specifications attached; when the stock is down to the minimum the tag is sent to the buyer's office and there the order is made out according to the specifications and a duplicate of the order is sent to the stock-keeper who records on the stock-cards the amounts ordered with date and order number; he then returns the duplicate which, when the bill for the goods arrives, is filled out with the itemized prices and bill number and again passed to the stock-keeper so he can complete his records.

In this place, the engineer's supply is supervised by the supply department, everything ordered being charged to this; the stock-keeper is charging the goods to the engine department as they are used. Special things not kept in stock are also ordered through the supply department and are charged to the power plant in bulk; a special card index is kept for these orders and a good plan is to have a card for each section of the power plant, placing a record of the order on the card for the section the goods are intended for.

The Engineer's Cost Account

If the cost of supplies and all other operating costs are checked up daily in a cost account, it will enable the engineer to compare costs at all times.

Considering, for instance, an electric driven ice factory, the main cost items would be something like the following: Contractor's bills, cost of labor (chief, operators, repair men, tank men), electric current, water, coal, gas, supplies.

The totals of these items should each be charged to the proper section of the plant; when several sections take each a portion of cost item total, the total should be apportioned out between the sections according to rates determined by tests or measurements, or, as in the case of supplies, an itemized list of the supplies with prices will show how to distribute the cost.

These sections of the plant could be indicated in the cost ledger as, heating system, ammonia system (high pressure or low pressure), tank system, ice-hoist and elevator (chute), lighting, electric system, sundries.

The grand total amount of the main cost items should equal the grand total of the sectional charges.

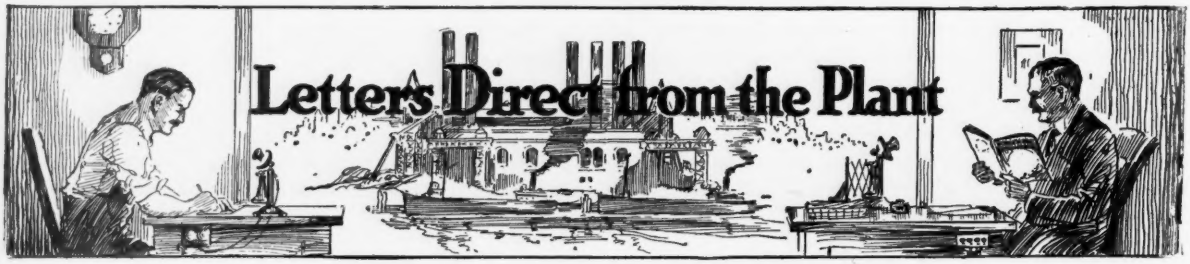
Monthly or half-monthly, the average daily expense can be figured for each of the cost items and the average cost per ton of ice manufactured determined.

A cost account can be arranged to meet the requirements of any kind of plant.

Letting the men in the plant in on it when good results are produced and starting a few friendly arguments about operating conditions wakes up an interest and makes for good fellowship.

The second largest building permit ever issued in Hartford, Conn., has been given by Building Supervisor Frederick W. Barrett to Stone & Webster, Inc., architects and builders for the steam-electric power station being erected on the South Meadow at an estimated cost of $2,815,000 for the Hartford Electric Light Co. The building, which will be of structural steel frame and concrete foundation, is to be four stories high. It will be 200 ft. long in front and 370 ft. deep. The smokestack will be 168 ft. high. Construction started last March, but a formal permit was not issued then because the supervisor was not furnished with sufficient plans.

The power plant of the Murray Light & Power Co., owned and operated by the city of Murray, Ky., was destroyed by fire recently, with loss estimated at $75,000.



Compensating Devices

SOME TIME ago one of my assistants asked the question: "What is a compensating device and what is its use?"

The dictionary says that to compensate is "to return value" or to "make up for."

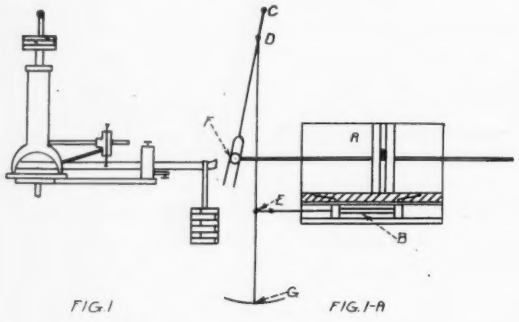


FIG. 1 FIG. 1-A

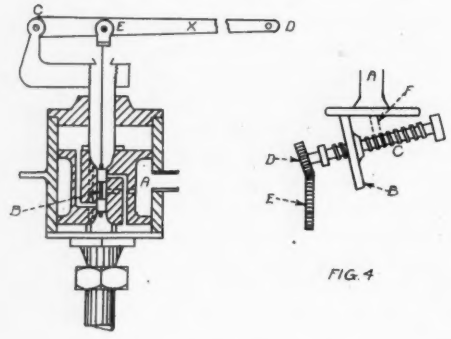


FIG. 2 FIG. 4

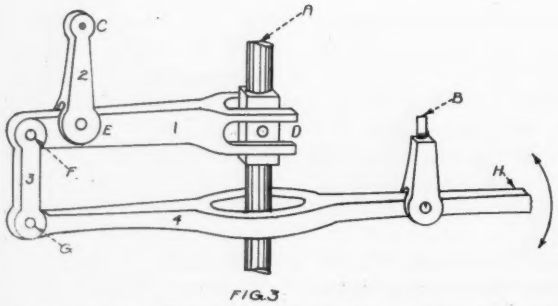


FIG. 3

FIG. 1. DAMPER REGULATOR AND DETAILS OF COMPENSATION
FIG. 2. DEVICE USED TO BRING PILOT VALVE BACK TO NEUTRAL
FIG. 3. COMPENSATING DEVICE FOR TURBINE GOVERNORS
FIG. 4. COMPENSATING DEVICE FOR WATER WHEEL GOVERNORS

In mechanics, a compensating device is an arrangement of levers, cams, cranks, etc., to return a pilot motion to its neutral position.

In the first hydraulic damper regulators, the pilot valve was operated from the diaphragm lever and when the pressure under the diaphragm was sufficient to move the pilot valve, the plunger in the cylinder was forced upward, closing the damper as in Fig. 1.

There was no mechanical connection between the plunger of the hydraulic cylinder and the pilot valve. Figure 1a shows the principle on which compensating devices are based. A is the motor cylinder, B the pilot valve chest, C the pin on which lever F swings, D the fulcrum of pilot valve lever, E the link connecting the pilot valve stem and pilot valve lever, G the point at which power is applied to the pilot valve lever.

Operation: It is desired to move the piston in cylinder A a proportion of its travel, say 3 in. The pilot valve lever is pushed toward the right a short distance. Pressure (hydraulic, air, steam) is admitted through the right-hand port which drives the piston toward the left. The tail rod of the power piston actuates lever F on pin C and moves pilot valve lever on fulcrum G, closing the pilot valve and stopping the piston. D is the fulcrum used to start the pilot valve from seat; but when compensation takes place G is the fulcrum.

This compensating device is used on the reverse gear in marine practice.

Figure 2 shows the method used by a well-known damper regulator builder for bringing the pilot valve back to its neutral position. The diaphragm lever in rising lifts lever X on fulcrum C, raising the pilot valve B through clevice E. Water pressure is admitted through the port between spool piston and lower head, lifting the piston. Fulcrum C, being a part of the piston rod, also rises, but D remaining fixed, the piston travels faster than the pilot and overtakes it, closing ports and stopping movement of the piston. This pilot being of the indirect type (piston valve) it is necessary to reverse ports in the piston as shown to get proper direction of travel.

In Fig. 3 is shown a compensating device used on governor valves for certain types of steam turbines. The governor actuates lever 4 at H. Rod B is pilot valve stem. When lever H is raised, the pilot valve is raised, admitting steam under the piston, which raises crosshead D, lever 1 on link 2 swinging from pin C, depressing link 3 on pin F and lowering lever 4. Link 3 is left out in some types of governor and lever 4 is forked all the way from pilot connection and couples directly to F. This does away with link 3, but crowds the gear more.

The damper regulator first mentioned in later years

adopted a compensating device whereby a chain and lever with cam raised or lowered the pilot valve seat to compensate for valve travel.

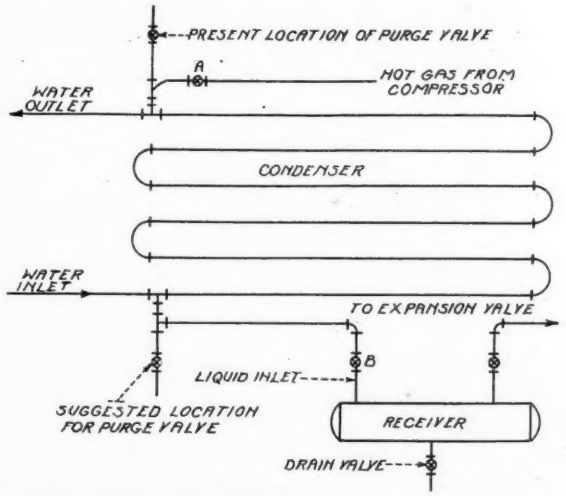
On damper regulators or hydraulic motors used as reducing valve motors, the compensating attachment reduces the main pilot travel one-half and likewise increases the sensitiveness of the operation wonderfully.

Compensating devices are not confined to hydraulic or steam operated motors alone, but are a necessity in mechanically operated water wheel governors as well. A well-known and much-used type of compensator in this service is that shown in Fig. 4. A is a revolving disk used to throw shipper which operates friction clutches to open or close gates. B is a friction disk upon which A rests. C is a threaded arbor on which B operates. When the gates are opened by the governor, gear E is caused to revolve, carrying gear D on arbor C. Disk B now travels on the screw, up or down as the case may be, lifting or lowering disk A, which in turn releases the friction clutch. The disk A resting on disk B and both revolving has a tendency to bring B always back to neutral position, which in turn carries B back to neutral F.

The hydraulic valves which control the elevators that carry us up and down every day are also equipped with compensating gears. TOM THUMB.

Purging Ammonia Condensers

WE HEAR and read so much about the enormous quantities of ammonia lost in the ammonia systems of refrigerating plant. One source of ammonia loss is in purging air out of condensers.



SUGGESTED LOCATION OF PURGE VALVE ON AMMONIA CONDENSER

It is my belief that almost all condensers are purged from the top; that is, from the purge valve located at the highest point on the condensers. Now, theoretically speaking, air is heavier than ammonia (density of ammonia is 0.59), consequently ammonia will always be on top and air on the bottom of the condenser pipe. What happens when the purge valve is opened? The ammonia gas escapes first and if there is a small amount of air in the condenser, we have to lose a quantity of ammonia to get the air out if it is possible to get it out at all.

It seems to me that the logical place to put the purge valve on a condenser would be at the lowest point between condenser and receiver. Then, if there is any air, it can easily be blown out without losing a great deal of ammonia, at least not as much as would be lost in purging from the top.

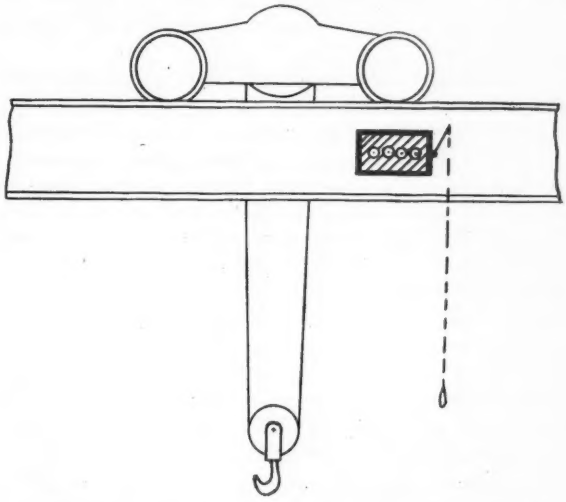
The accompanying sketch will illustrate my point.

When it is suspected that air is in the condenser, shut valve A at the top of the condenser, thus shutting off the hot gas from the discharge of the machine. Next shut off valve B in the liquid line to the ammonia receiver. Let a supply of condensing water circulate through the condenser. Then the gas in the condenser will be condensed and if there is any air in the condenser, it will settle at the bottom where it can easily be blown out.

I would like to have the opinion of operating engineers on this point. R. J. SOLOMON.

Counter on Ice Room Crane

THE ACCOMPANYING sketch shows a convenient arrangement for counting or registering the number of ice cakes pulled in the freezing room. In our plant,



CRANE FITTED WITH COUNTER TO RECORD NUMBER OF CAKES OF ICE PULLED

there seems to be considerable difficulty in striking a balance between the number of ice cakes claimed to have been "pulled" in the freezing room and those delivered to the platform and the discrepancies became so great that we decided to check up on the platform count by instituting a positive count in the "pulling" room. We first tried marking the count on a tally sheet, but this took time and the plan was not readily taken to by the ice pullers.

We finally hit on the scheme illustrated which simply involved a plain counter attached to the crane bridge, with a conveniently hanging cord by which the count could be quickly registered by a pull or two as the cakes were pulled. M. A. SALLER.

Using Metallic Packing

I NOTE A LETTER on page 628, June 15 issue, wherein Tom Jones asks for information on using metallic packing.

Having had some interesting experiences using some nine different makes of metallic packing—so-called shredded packings, moulded rings, etc., on sea and land, high pressure and low pressure, 3500-lb. hydraulic pressure, etc., and 1200-lb. air pressure, etc., and as my experience covers placing the metallic packing both on new rods and also its installation some weeks later after rods have become somewhat glazed, I have to record that I have had greater success by placing the metallic packing on the new rods and letting them get broken in, as they say, together.

On locomotive work, my experience covers two locomotives only—yard engines, but busy ones. The rods were old, but we turned them down true and ground them on centers, got a high polish on them and applied the packings, also valve stems. Soft gray cast-iron packing rings seem to have given us the best and longest service. Of course, the cylinder openings were bushed with a babbit ring and given only 1/64 in. clearance; and if guides are properly adjusted to prevent lifting and dropping of piston rod, the cast-iron rings will glaze the rod nicely and if proper lubrication is applied constantly, no leakage will take place and the wear on rod and packing will be negligible during several years of operation.

If packing starts blowing at times, it indicates that grit or scale has wedged between some of the rings. It is advisable to remove the packings rings and clean them properly; but here is a note of warning—be sure to replace all rings in the same relative position they occupied previously. If you don't—well, you'll be sorry you took the rings out at all; you'll wish you'd let well enough alone. It is easy to mark each ring as they are removed or set them on a bench in relative position that they occupied in the stuffing-box.

Hard babbit rings also give excellent service. They have the advantage that even though lubrication is forgotten for a few hours, no harm results, which is not the case where gray cast-iron rings are used. The latter will start cutting and there is danger of scoring the rod.

Constant lubrication, not necessarily copious lubrication, is needed. I've had fine results with three drops of cylinder oil per minute on a 4-in. diameter rod with gray cast-iron rings with 640 ft. piston speed per minute. Oil was compounded for wet steam and clung to rod and gave fine service. On 1200 lb. air down to 800 lb. on three-stage compressor, the cast-iron rings gave better service than babbit rings, the latter wearing too fast and leaking after 14 mo. service. We got 34 mo. service with cast-iron rings and no leakage to speak of.

Cast-iron rings must be scraped to fit absolutely; no halfway measures will go here. I've taken a mandrel turned and ground true on center of same diameter as the rod to be fitted, and turning this mandrel at high speed in a lathe, have used pumice and water and ground in the metallic packing rings and obtained the finest results quickly.

As to using an oil cup and dropping cylinder oil on piston rods, using fibrous packing, I want to go on record as having saved an average of three packings a year on each Corliss engine—using four enginess—fully $50 saved. I'm using oil cups now on pump rods and get fine service—less friction, packing does not get hard until after long service and I would not consider it harmful to packing after my experience in several plants. I generally apply an oil cup at first opportunity after changing plants; have done so for 20 yr. The packing always has lasted longer and my friction cards show less steam used in every case, compared with cards taken before application of oil cups to piston rods. Two to three drops a minute are all that I ever use or intend to use.

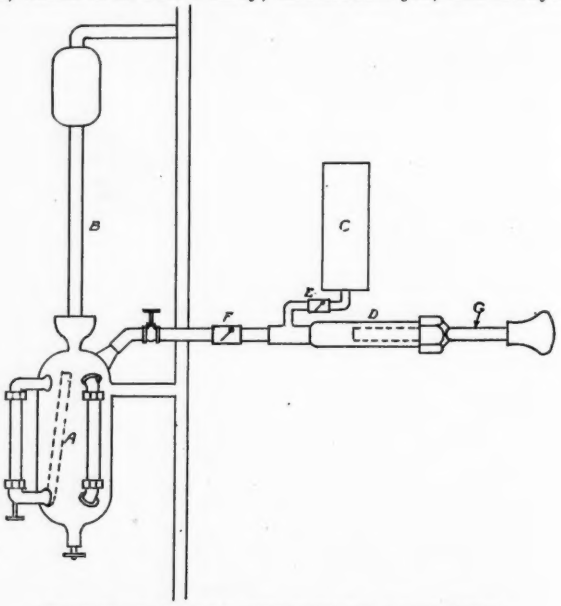
My advice is to purchase metallic packing for all new rods; if possible, specify metallic packing and have the builders test the engine with the packing; break in the two together and you'll get results that are pleasing. Watch the rods, however; give them your regular attention; clean the rings when they show signs of distress, but unless they show signs of distress leave them alone.

Oil the piston rods, using any kind of fibrous packing; a compounded oil gives best service on steam rods, a straight mineral oil on air-compressor rods, and ammonia-compressor rods, both metallic packed and fibrous packed.

D. L. FAGNAN.

Filling Lubricators

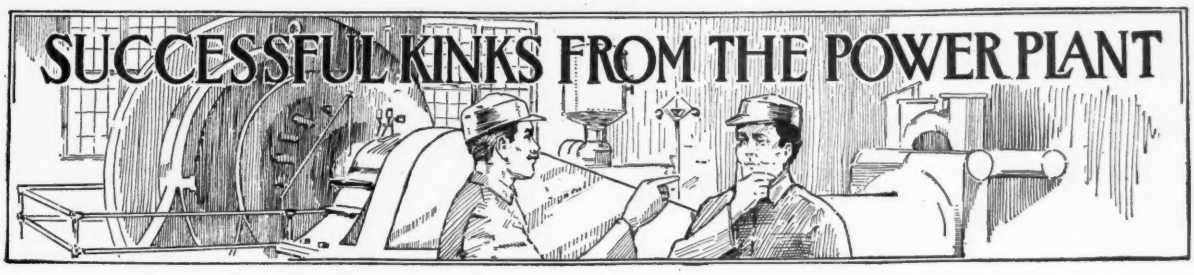
THE ILLUSTRATION represents a homemade lubricator filler, which does away with the usual method of taking the plug out, draining out water and filling with cylinder oil, which is at best a dirty, undesirable job, and always



METHOD OF FILLING HYDROSTATIC LUBRICATOR

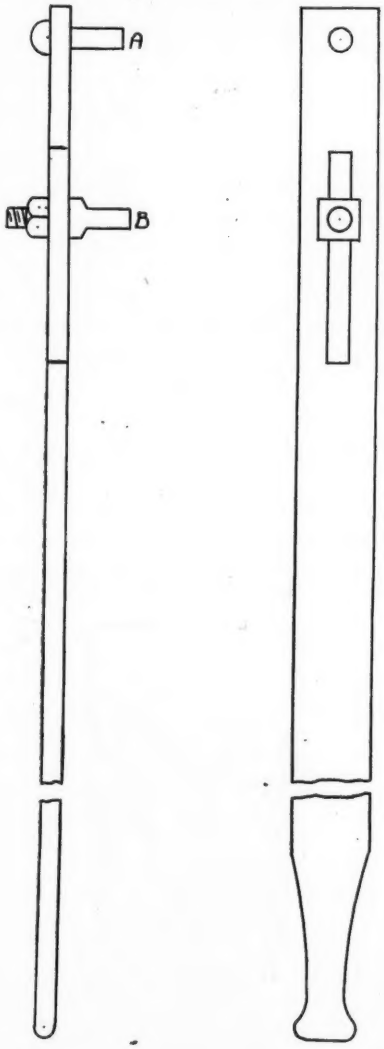
wastes some oil. Get ½-in. brass pipe, 8 in. long, for plunger barrel, with threads on each end, then get a stuffing-box nut to fit on outer end, ream out its hold to fit a ⅜-in. plunger, G, which is a plain ⅜-in. rod. This need not fit tight in barrel, D, or even touch the sides any more than a power pump plunger does. Put on ⅜-in. check valves, as shown. Fill the reservoir, C, and inject the cylinder oil into the lubricator, which will back the water up pipe B as fast as you put oil into the lubricator. The amount put in will show in glass A. This is very simple and inexpensive and well worth the time required to make it.

A. WALDRON.



Flange Wrench

VARIOUS flange wrenches have been described in the technical journals, but the one shown by the accompanying sketch is a new one to me. It consists of a flat bar of iron of any desired width, thickness and length. Pin

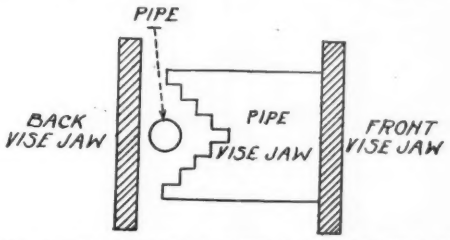


FLANGE WRENCH EASILY ADJUSTED TO DIFFERENT SIZES OF FLANGES

A is riveted into place. Pin B can be moved along the stated hole by slackening the nut, thus different distanced flange holes can be reached. J. E. JAMES.

Single Jaw for Pipe Vise

THE ACCOMPANYING sketch illustrates the method by which I made a single pipe vise jaw do the work of a complete pipe vise. The jaw and the pipe was clamped

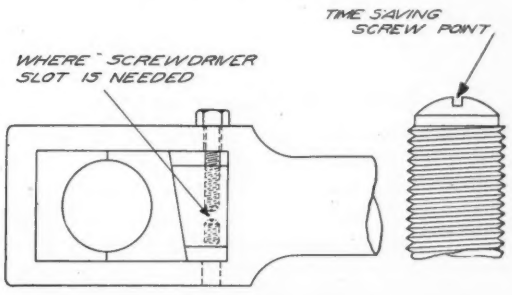


METHOD OF HOLDING PIPE WITH A SINGLE PIPE VISE JAW

between the jaws of an ordinary vise. The sketch is self-explanatory. R. G. SUMMERS.

Improved Connecting Rod Adjusting Screws

AN IMPROVEMENT which ought to be made by engine builders is to make a screwdriver saw cut at the end of every adjusting screw in the taper wedge of connecting rods. When the end of such a cap screw breaks off, it is often an unhandy proposition to get the broken piece out. If there was a slot on the end, it would be



SOME ADVISABLE IMPROVEMENTS TO ENGINE PARTS

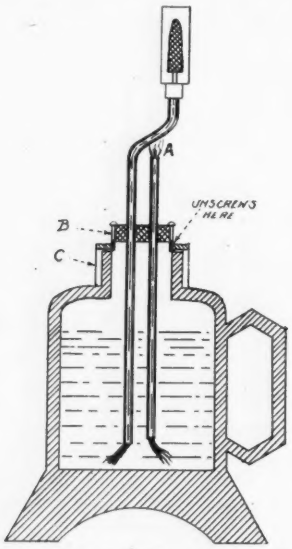
very simple by just taking the other screw out, insert a screwdriver in the hole and screw the broken piece out.

When making a stud or any screw on the lathe, why not cut the first thread down and round the point? This may take a little more time, but I know from experience how it saves in erecting. CHARLES LABBE.

A Useful Alcohol Lamp

MY ONLY reason for sending a description of this homemade alcohol lamp is that I am well aware that men, engineers in particular, like to putter around and make some useful thing in what would otherwise be idle moments. The lamp shown can be made from a few

odds and ends. The body of the one shown is an old coaloil lamp glass reservoir. The piece C is the brass collar that held the burner; the piece B is the screw cut off from the old wick burner; two pieces of ⅛-in. iron pipe are used as shown, and the filling around the pipes can be iron cement. The ordinary gas burners are the same size and same thread as ⅛-in. iron pipe. Cotton wick is used inside the tubes; it can be a snug fit but not tight.



SECTION THROUGH ALCOHOL LAMP SHOWING ITS CONSTRUCTION

To light the lamp, apply a match to the wick at A and in a few seconds gas will form and the gas at the mantle will burn when a light is applied. To put out the light, place a small cap (a small thimble will do) over end A. This puts out the generating flame and stops the formation of gas. Wood alcohol can be used.

JAMES E. NOBLE.

An Easily Made Paint Gun

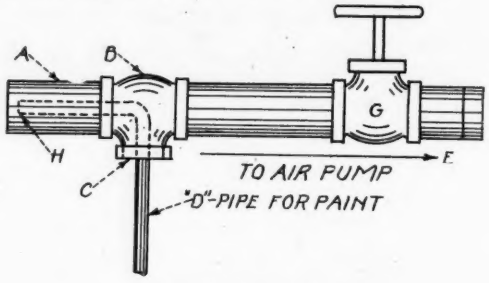
THE ACCOMPANYING drawing is of a paint gun, which has been useful about the power plant where the writer is employed and which can be made at small cost.

Any of the readers who have painted windings, etc., of electrical machinery know how little can be done with a brush. There are parts too small or too close to allow free use of the brush, and that is where the paint gun shows its worth. One advantage is that while being used to paint windings, etc., it not only paints them but blows the dirt out before the paint comes in contact with the article or machine to be painted. It has also been used for painting boiler room walls, boiler front, as well as for removing grease of long standing by use of gasoline to soften it.

Its make-up is as follows: A is a ⅜-in. nipple about 3 in. long; B is a ⅜ tee; C is a ⅜ plug with the top sawed off; D is a ⅛-in. piece of copper tubing.

A hole is drilled into the plug C and tube D soldered in. The nipple, A, can be sawed off as long as desired and cut to form the desired spray, as all jobs will not require the same. If the nipple, A, is made up after the bend in the pipe, D, has been inserted and soldered in, it will simplify matters. Valve G can be inserted or left out at the pleasure of the maker, inasmuch as there is a valve at the source of supply. This valve is not exactly necessary, since by removing the gun from the paint container the supply of paint will be cut off.

When using the gun, care must be taken to use paint which is free from lumps and which will flow smoothly. On several occasions when the writer had loaned the gun out, the borrower returned it saying it could not be used with the paint he had. This, of course, was due to the fact that the paint was lumpy.



HOMEMADE PAINT GUN

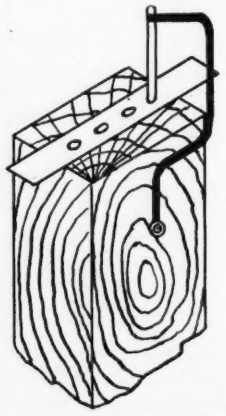
If difficulty is encountered with the gun clogging up, it can be quickly cleaned by placing the nozzle upon some flat surface keeping the air pressure on; the air will thus back up into the tube and clean it thoroughly.

The gun is not made for spreading cement or heavy paint, but with paint and varnish of fair consistency will work nicely. The tool can be kept perfectly clean by the aid of two small pails and some gasoline, blowing the gasoline from one pail to the other.

W. HANCORSED.

A Metal Punch for Shop Work

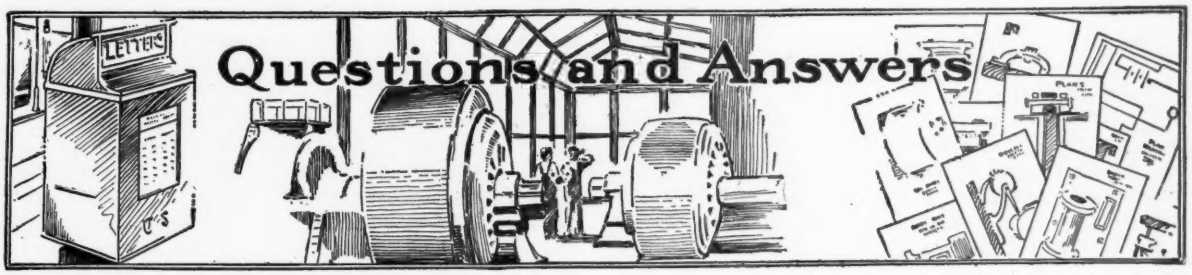
A GOOD sheet-metal punch for ordinary shop work may be made as shown in the diagram. A bolt of the desired diameter with a tempered punch point is suspended over a hardwood block by a stiff piece of spring wire. A hole is bored in the block to register with the



CONVENIENT PUNCH HOLDER

bolt and act as a die. When a piece of sheet metal is placed under the bolt and the bolt hit with a hammer, a clean-cut hole will be made. If the top of the block is covered with a plate of iron having a hole to correspond with the bolt, better results will be obtained.

F. H. SWEET.



Condenser Tube Information Desired

A JOINT investigation is being undertaken by the General Electric Co., of Schenectady, and the Diamond Power Specialty Co., of Detroit, on the subject of the life of condenser tubes. The investigation is undertaken with the object of determining the possibilities of utilizing calorized copper tubes in this field.

Calorizing has, of course, proved its value in preventing oxidation of soot blower units, pyrometer protection tubes and other equipment at points of high temperature. What is not so generally known, however, is that calorizing has been utilized successfully for some time under certain conditions as a means of preventing corrosion.

Information is desired from engineers engaged in both stationary power plant and marine work respecting the service which they are getting from their condenser tubes. The co-operation of such engineers is requested and will be very greatly appreciated. In order to be of value, the reports sent in should contain as specific data as possible on the following points: (A) Metal of which tubes are made, (B) Size and length of tubes, (C) Life of tubes.

Communications on this subject should be addressed to Robert June, Diamond Power Specialty Co., Detroit, Mich.

Vacuum Pumps and Receiver Pressure

I WOULD APPRECIATE your answer to these questions which were put to me in an examination for an engineer's license.

1. What is the difference between a dry and a wet vacuum pump?

2. What danger is there in starting up a compound engine with a high receiver pressure? A. J. K.

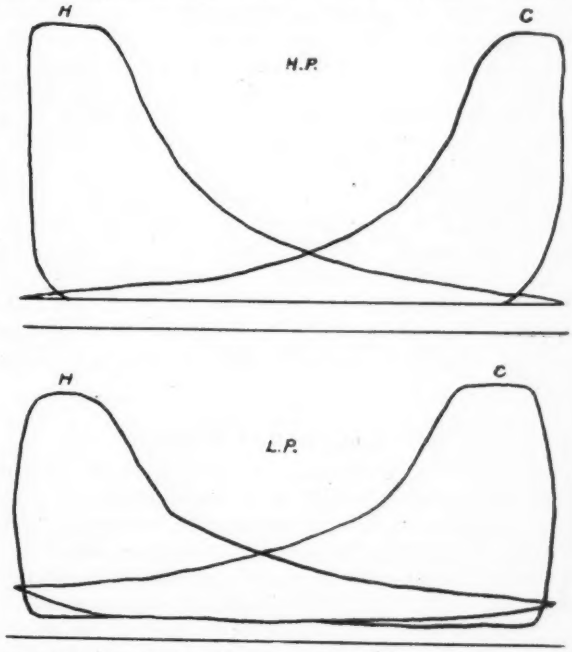
ANSWERS

THE DRY VACUUM pump takes the vapor and gases from the top of the condenser and discharges them to atmosphere. This pump handles no water except such as many come over, carried by the gases. The wet vacuum pump takes its suction from the bottom of the condenser and handles the water of condensation. If there is no dry vacuum pump, it has to handle also the gases and vapors, hence, must run much faster than for the condensation alone, and cannot maintain so good a vacuum in the condenser.

2. If the receiver pressure in a compound engine is very high, it will result in a long expansion and short cutoff in the low-pressure cylinder. This may produce a pressure at the end of the stroke less than that in the exhaust pipe, and when the exhaust valve opens, there may be a chance to drive the water back from the condenser into the exhaust, especially in the case of a jet condenser. Since the low-pressure cylinder and reciprocating parts are made to carry only a low pressure, there is also a possibility that if high receiver pressure is carried, the parts of the low-pressure side of the engine will be over-strained.

Can You Improve These Cards?

THIS SET of cards was taken from a Rice & Sargent cross compound engine of 960 hp., driving an electric



INDICATOR CARDS FROM A RICE & SARGENT CROSS COMPOUND ENGINE

alternator. The steam pressure is 135 lb., receiver pressure, 48 in. diameter. We maintain a 25-in. vacuum and Will readers kindly suggest improvements? P. F.

Efficiency of Combustion

IN POWER PLANT ENGINEERING of Nov. 1, H. W. B. asks: "How many pounds of water at 195 deg. can be changed to steam at 85 lb. gage by the combustion of 1 lb. of hydrogen, assuming 3 per cent lost?" The answer was: "One pound of hydrogen burning to water gives up 62,000 B.t.u. gross. This is not all available, however; 9 lb. of water are produced, which must be heated to the temperature of the steam at 85 lb. gage. Assuming 60 deg. F. as the room temperature, this will

amount to 1205 — 28 = 1177 B.t.u. per pound or 10,593 B.t.u.; 62,000 — 10,593 = 51,407 B.t.u. available. Heat required to change water at 195 deg. to saturated steam at 85 lb. gage is 1023.3 B.t.u.; 51,407 ÷ 1023.3 = 50.23 lb. of water which can be evaporated under the foregoing conditions by the combustion of 1 lb. of hydrogen."

The answer is in error. Instead of the unavailable heat being represented by the heating of 9 lb. of water (resulting from the combustion of the hydrogen) to the temperature of steam at 85 lb. gage, it is represented by the heat of 9 lb. of steam at the temperature of the chimney gases. Assuming this temperature as 500 deg. F., the specific heat of superheated steam as 0.463 B.t.u.; the atmospheric temperature as 60 deg. and a 30-in. barometer, then the heat of the 9 lb. of steam is as follows:

Superheat	9(500 — 212).463	= 1200.1 B.t.u.
Latent heat	9 × 970 4	= 8733.6 B.t.u.
Sensible heat	9(212 — 60)	= 1368.0 B.t.u.
Total		11301.7 B.t.u.

It was not stated in the question why a loss of 3 per cent was assumed. The loss from the heating of excess air and from radiation is several times 3 per cent. Assuming, however, that these losses are 3 per cent, the heat available for steam generation is (0.97 × 62,000) — 11,301.7 = 48,838.3 B.t.u.; and the water evaporated from a temperature of 195 deg. to steam at 85 lb. gage is 48,838.3 ÷ 1023 3 = 47.73 lb. C. O. SANDSTROM.

Editor's Note.—The answer to this question, as it appears in the Nov. 1 issue assumes conditions as they might obtain in a laboratory test. None but inherent losses are considered. Mr. Sandstrom assumes what might be practical conditions. We agree with him that 3 per cent is entirely too low for practical operation. We disregarded it altogether. The difference in the results obtained is entirely due to the difference in assumptions made.

Indicating Diesel Engines

IN ANSWER to the inquiry by "Diesel" in the issue of Sept. 1, regarding indicating a Diesel engine of more than one cylinder, I would say that it is better to have an instrument for each cylinder in order to obtain the indicated horsepower developed. With this arrangement, all of the cards should be taken simultaneously.

About a 400-lb. spring is necessary and as to the way of knowing the proper spring to use, it should be known by every Diesel operator that the compression in these engines is around 450 lb. per sq. in. or they will not be able to ignite the fuel. For medium speed work, it is well to have a compression pressure of nearly 500 lb.; but in high-speed marine engines, better results have been obtained with 450 lb. per sq. in.

Special forms of indicators are on the market which are adapted to Diesel engine work. Some indicators, instead of having a piston of one square inch in area, are provided with one of one-half that area or even smaller so that the total pressure on the piston will not exceed 125 lb. The connecting parts which attach the indicator to the engine cylinder should be heavy enough to stand about 800 lb. pressure and with a small-sized piston, the remaining parts would have no heavier strain than any steam-engine indicator.

Each cylinder is provided on the working side of the piston with a plugged hole, and some engines have regular indicator cocks, to which the connection can be made, and like steam engine practice it is best to have the indicator as near the cylinder as possible. The heat is not great enough to be of special moment.

As to reducing the motion of the piston travel, sometimes an arrangement with as many cranks as there are in the engine and each crank fitted with a connecting rod and driving a crosshead to which the cord may be fastened, is used. The cranks are set in line with the main cranks and the whole is usually clamped to the end of the crank shaft and the cord is run over pulleys to the indicators so that each instrument moves in time with the piston of the cylinder to which it is connected. One type of engine has a small shaft driven from the cam shaft on which is provided an eccentric for each cylinder whose rod connects to a hook lever so that the indicator on each cylinder can be driven with a short cord with very little trouble. This shaft is driven by a clutch which can be thrown out when it is not needed.

G. H. KIMBALL.

Engine Foundation Finish

WHEN SHOULD the finish of a foundation for a heavy machine be applied? Should the sides be finished with cement plaster about 24 to 48 hr. after concrete is poured, to prevent peeling off at some later time, or is it satisfactory to wait till the machine is set and grouted in and then finish top and sides of foundation with cement plaster?

In the first case, the handling of erecting tools would damage the finish, but would have a better binding.

B. E.

A. In regard to the finish on your foundations, you can use either of two methods: First, to give the finish what is called a carborundum finish, by rubbing down with carborundum stone immediately after the forms are stripped. This will give a pleasing appearance and avoids all expense of the plaster finish, and the cost is less than the plaster.

If, however, the cement plaster is essential, this can be put on after the machine is set and grouted; but the surface of the concrete should be left rough so that the plaster coat may have a good bond.

Before applying the plaster coat, wash the old concrete clean, brush it over with cement wash and put on the plaster coat immediately. This plaster coat should be of an appreciable thickness but, of course, not too thick and not richer than a 1 to 2 mix if it is to be subjected to the direct rays of the sun.

Power for Pumping

PLEASE TELL ME what horsepower gas engine will be required to pump 30 gal. of water per minute through a 2-in. pipe 2500 ft., and elevate it 70 ft. The lift is 10 ft.

Also please tell me what formula to use in solving such problems. F. R.

A. The formula for finding the friction head loss in a pipe is as follows:

$$F = .03\ Q^2 \div D^5$$

Where Q is the gallons per minute, D is the actual inside diameter of the pipe in inches and F is the pounds

pressure loss per 100 ft. length of pipe. This works out in your case for 30 gal. per minute in a 2-in. pipe, the internal diameter of which is 2.06 in. to 1.1 lb. per 100 ft. This will be equal to 2.54 ft. head loss, and for 2500 ft. the total loss will be 63.5 ft. head. The lift for the pump will then be $10 + 70 + 63.5$, or 143.5 ft. Thirty gallons at 8⅓ lb. per gallon will be 250 lb.; so that the work done per minute will be 143.5×250, or 35,900 ft.-lb. per minute.

One horsepower is 33,000 ft.-lb. per minute, so that the horsepower required would be $35{,}900 \div 33{,}000 =$ 1.085 hp. to handle the water.

Assuming a pump efficiency of 75 per cent and an engine efficiency of 75 per cent, gives a combined efficiency of 56.6 per cent, and dividing 1.085 by 0.57 gives 1.91 hp. for the engine.

As a gas engine has practically no overload capacity beyond its rating, it would be well to provide at least a 2½-hp. engine to take care of the emergencies.

Precipitation of Chalk from Lime Water

WILL YOU KINDLY give me answers to the following questions:

(1) Why is it necessary to let in air through the fire door when burning wood under a boiler?

(2) Why does charcoal not turn lime water white?

(3) What causes white smoke from a piece of wood to turn lime water white? C. A.

ANSWERS

WHEN burning wood, there is a large amount of volatile gas generated, and in order to burn this properly, air must be admitted above the fire the same as when burning a soft coal containing a large amount of volatile matter.

2. Lime water is, in chemical language, calcium hydroxide, and will absorb carbon dioxide, giving it a milky appearance, and will throw down calcium carbonate or chalk. When charcoal, which is pure carbon, is put into lime water, it has no effect as there is no carbon dioxide.

3. The smoke from a piece of wood or from a soft coal fire will contain a considerable amount of carbon dioxide, which gives the milky appearance.

Change in Receiver Pressure

HERE ARE some questions asked me recently in an examination for a first class Massachusetts engineer's license. Will you answer them for me?

1. Why doesn't a smoke flue in the upper drum of a Cahall boiler require stayings like the furnace sheet of a vertical fire-tube boiler?

2. If the lower head of the bottom drum of a Cahall boiler is braced to the lower tube sheet which needs the bracing?

3. If you have, say, 150 lb. steam and 10 lb. receiver pressure on a compound condensing engine and with the same load your steam went down 20 or 25 lb., would your receiver pressure change? W. S. H.

ANSWERS

THE SMOKE FLUE in the upper part of a Cahall boiler is of comparatively small diameter, short and has a reinforcing ring around the middle. It is, therefore, in the same condition as an internal furnace in a Scotch boiler and can carry the steam pressure on the outside without supports.

(2) If stays were used in the bottom drum they would be for the purpose of supporting the lower head, but this is made convex outward, which is approximately the shape it tends to assume under pressure; therefore it does not ordinarily require staying.

(3) The effect of varying initial pressure on the pressure in the receiver would depend on the way the governor acts. If this controls cutoff only in the high-pressure cylinder, this cutoff will be lengthened as pressure drops in order to carry the same load. The cutoff in the low pressure cylinder would not be changed and this would mean that the pressure in the receiver would rise, since a greater volume of steam would be thrown in from high-pressure cylinder and no greater volume taken out by the low-pressure. If the governor acts on both high and low-pressure valve gears so that the cutoffs are lengthened in proportion, there would be no change in receiver pressure for a drop in initial pressure.

Feed-Water Heater

WHAT IS THE BEST method of feeding water to a boiler: Pumps or direct return steam traps?

If pumps are the best, what are the main arguments for the pump and against the steam trap? W. P. J.

A. Where direct-return steam traps can be used to feed a boiler or boilers, it is usually a more economical method than the use of steam pumps; this all depends, however, on the conditions in the plant.

Where returns from a heating system are fed into a boiler, unless the boiler is low enough so that the returns can feed by gravity to a trap located 4 or 5 ft. above water level in the boiler, it is necessary to use two traps; one to force the water up to the trap above the boiler by means of boiler pressure steam; the other a direct return trap to dump water into the boiler. In such a case, the cost of a trap installation is, of course, higher than that for a pump, which can force the water directly into the boiler without rehandling. Where the feed water of the boiler is not made up entirely of condensed steam, and the load is variable so that the amount of feed must be varied, the speed of the feed pump can be controlled more easily than a trap. The trap simply dumps into the boiler whatever water comes to it, and, of course, the rate of flow into the trap could be regulated by the valve in the supply line. Where cold water is used for feed and has to be heated, it is difficult to arrange the system so as to feed through a trap, as either the feed heater must be located above the trap or a lifting trap be employed to take water up to the direct-return trap.

The chief argument for the pump is convenience and flexibility, and adaptability to all conditions.

THE NEW YORK EDISON CO. will soon begin the erection of its new power house in the Port Morris section of the Bronx. The building will cost $5,500,000 and will be located on Locust Ave., near the East River, and will extend from 132d to 134th Sts. The company chose this site because of its acessibility to the East River, which will permit the largest colliers to unload coal directly at the power house.

POWER PLANT ENGINEERING

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Opportunities for American Engineers

At every opportune moment, somebody remarks that American industries should be extended to foreign countries and many of our most progressive manufacturers are taking advantage of conditions which exist throughout the various countries to export equipment to places where the demand is most urgent. Little thought, however, seems to be given to the training and development of Americans who should accompany this machinery to see that it is properly installed and operated.

Manufacturers who have gained greatest prominence in our own country are those who have kept in closest touch with their customers, not only their needs to be supplied, but the difficulties to be overcome in the operation of their apparatus. This same service must be supplied to the foreign customer as well as the domestic.

It is unfair to expect a foreign customer to patronize a manufacturer who merely sells equipment. Our domestic customers, who are at most only a few hundred miles from the factory, show preference to the company which keeps an expert engineer in the district who can be called in on emergency cases within a few hours. The foreign customer needs such experts far more than the home plants.

The requirements for an expert representative in a foreign field are much broader than those for a territory near the factory. He will be required to know in detail more kinds of machinery; he must familiarize himself with the language of the country, with the customs of the people, with their methods of working, with the firms upon whom he must call for supplies and repair work, with the fundamental laws of the country; he must be a diplomat capable of dealing with government officials as well as common labor. It is a broad field worthy of the efforts of any engineer and such men must go from America if American manufactured machinery is to meet with permanent success in foreign countries. A capable American engineer to superintend the operation of each foreign plant in which American manufactured machinery predominates will go a long way toward extending foreign trade.

Care of Safeguards in the Power Plant

Reviewing the advances in the development and design of safety devices for the protection of life and property in the power plant, one is struck with the many ingenious and effective appliances available for this purpose. Indeed, the high state of development in this line is only eclipsed by the marvelous achievements attained in the design of power plant machinery itself. From a simple guard rail around a flywheel to intricate centrifugal or electrical speed limiting governors for high speed engines and turbines, these devices seem to forestall almost every possible emergency.

Yet, in spite of the numerous means and methods of protection, we continue to read daily accounts of flywheel explosions, boiler explosions, turbine and generator failures, etc., with their consequent loss of life and destruction of property. What is the reason for this? Are the protective devices unreliable?

Protective devices, with few exceptions, are, as a whole, reliable; if properly installed and cared for. They must, however, receive the same, if not more, careful

attention than the equipment they are designed to safeguard receives. Their location should be such as to enable them to function properly in case of emergency.

Safety appliances are, in a great many instances, more or less delicate pieces of mechanism, and unless properly cared for, cannot be expected to render the very high grade of service demanded of them. Engineers should test them frequently and see to it that they are kept oiled and in proper adjustment.

Merely because of the fact that a machine is equipped with a protective device is no reason for lessening vigilance with regard to safety. The engineer as an individual can do much to eliminate and reduce hazards in the plant by the proper location of and attendance to protective devices; he is responsible for the proper working of such appliances. Much may be accomplished by the use of guards. Governor guards, belt guards, flywheel guards, etc., may all be used to advantage. Even the layout of the plant has its bearing upon the question of safety and it is well in all cases to follow the advice of a well-known engineer, "Never locate the chief engineer's office in line with the cylinder head of an engine."

Palliative Measures

Two of the most common faults possessed by the average man are forgetfulness and procrastination. These shortcomings can at times be very expensive and oftentimes cause a great deal of unnecessary worry and extra labor.

As winter is coming on and ice is beginning to form around the edges of some of our still waters in the more northern sections of the country, certain of our hydroelectric power plant engineers are beginning to recollect some of the troubles they encountered last winter with ice jams in the forebay of the station.

It is supposed and hoped that these men will profit by their experience and fare better this winter. To those engineers who have not had sad experiences along this line, it may be well to emphasize the importance of the situation and the great responsibility of the engineer in charge. Imagine your plant shut down, incapacitated, for a period of days or weeks due to ice blocking the penstocks of your turbines because of your neglect in the matter of taking steps to prevent this situation. Suppose yours is a plant that supplies current to a town or community for lighting and power where continuity of service is a matter of first importance to be considered before costs, before personal hardships, before everything. Imagine what would happen, plants shut down, men thrown out of work and idle, no water supply at a time of the year when fires are most frequent, no lights, nothing but hardship and discomfort. And who is responsible? The engineer on the job at the generating station. Does it not behoove you to do something to keep your plant in operation?

Mr. Carpenter has something to say as to how this result may be accomplished in his article on "Ice Protection for Hydroelectric Plants," which appears in this issue. The time has passed for putting in adequate permanent improvements to forestall that trouble this winter. Nevertheless certain steps should be taken if we wish to operate this season without a serious curtailment of output or even a complete shutdown. Mr. Carpenter's suggestion of installing a log boom is both good and timely. The idea can be easily executed and there is no reason why it should not be, where other means are not provided.

Take palliative measures if you must, but at the same time plan for lasting improvements.

Power Plant Slogans

Store Coal in Summer.
Keep and Analyze Operating Records in Every Power Plant.
Develop Water Power Sites.
Promote Health and Safety in Power Plants.
Handle Coal and Ashes Mechanically.
Employ Engineers for Engineering Work.

Off Duty

Suppose after going to a store and buying a dozen of oranges you found that they had given you only eight although you had paid for a whole dozen. What would you do? Well, by the great horn spoon, we'd go back and get the other four or else lick the storekeeper!

And now for the sake of further illustration, suppose that you went into a motion picture theatre and were forced to sit in absolute darkness (with a dark screen) for about 20 to 30 min. Would you register a complaint? You say you would? Well, we guess you wouldn't.

Because that's just exactly what happens every time one goes to the movies. From 15 to 20 min. of every hour that we spend there, we sit in absolute darkness, but we don't complain in the least—because we do not realize it. This is due to a defect of the eye—a fortunate defect, however, for upon it is built the success of the entire motion picture industry.

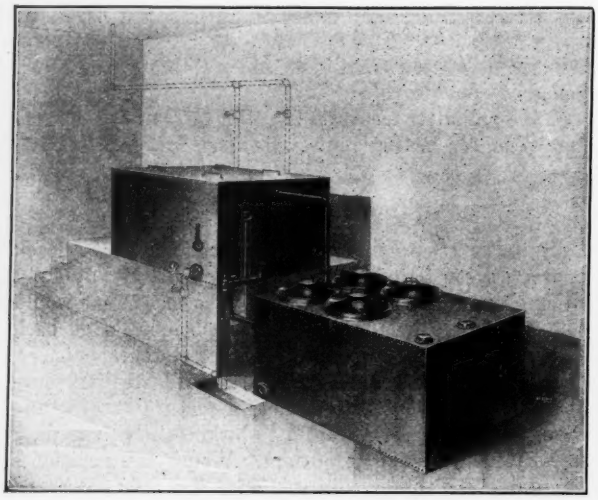
When we look at an object and then suddenly have that object drawn away from our field of vision, the picture of the object persists in our eye for a very short time afterwards. This peculiar property of the eye is known as the persistence of vision.

In the motion picture projector, approximately 16 separate pictures pass behind the lens every second. These, however, do not pass through smoothly but rather in a series of jerks. Each picture occupies a position in the field of the lens for a short interval of time while the shutter is open. Then, as the shutter closes, the film is suddenly jerked down so as to bring the next picture into the field of the lens. The interval of darkness (when the shutter is closed), however, is very much shorter than the time during which the picture is shown. It is so short, in fact, that the image of one picture has not died away in our eyes before the next succeeding picture appears. Thus, we see it as a continuous picture, endowed with motion due to the progressive translation of the objects on the film.

Since the dark periods are about one-third as long as the periods of illumination, 20 min. out of every hour we look at the pictures are spent in total darkness. Since we can't detect it, however, we don't mind and let it go at that. Ignorance is bliss.

Cutting Oil Filtration and Sterilization

EVOLUTION of machine shop practice, requiring high-speed tools, carried with it efforts of extreme accuracy in machining and the element of increased production. With the speeding up of tools, it was readily recognized that in order to keep down operating costs and get a product of the highest quality, it would be necessary to use a cutting fluid which had not only the cooling properties necessary to absorb excess heat, but lubricating qualities as well, to increase accuracy, decrease the power consumed, and at the same time speed up production.



FILTER FOR CUTTING OIL

With the production of a cutting oil which would serve the double purpose came increased cost and this item must, of necessity, be kept at the lowest possible figure. It was, therefore, apparent that an equipment which would filter and sterilize the liquid would eliminate the necessity of throwing the used oil away.

To meet this need, S. F. Bowser & Co., Inc., designed a filtering and sterilizing system which will soon be placed on the market. The illustration gives a good idea of its appearance and construction. These embody the principles of screening, precipitation, filtration and sterilization all combined in one unit.

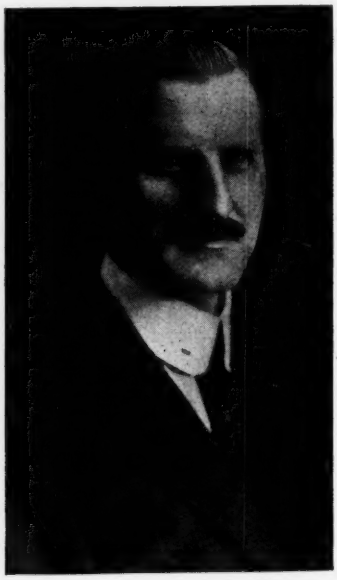
From the machines and chip separators, the oil, either by gravity or special provision, can be delivered to the filter and sterilizer which automatically removes foreign matter and sterilizes the fluid. After going through a series of compartments, screens, filtering devices, etc., the liquid is delivered to the filter tank, which acts as a temporary storage. From this tank, the oil can be returned to the different machines the same as new oil and used again.

U. S. CIVIL SERVICE COMMISSION announces an examination for computer, Coast and Geodetic Survey, on Dec. 15 and 16, to fill vacancies in the Coast and Geodetic Survey, Washington, D. C., at $1400 a year, plus temporary increase granted by Congress of $20 a month, and vacancies in positions requiring similar qualifications, at this or higher or lower salaries. Apply for Form 1312, stating the title of examination desired.

A. S. M. E. New President

EDWIN S. CARMAN, recently elected president of the American Society of Mechanical Engineers, to take office Dec. 8 at the annual meeting, was born in 1878 at Prairie Depot, O., and after high school education studied at the Central Manual Training School in Cleveland. Beginning with the Sun Oil Co. of Toledo, he changed after 4 yr. to the American Machine & Mfg. Co., of Cleveland, and in 2 yr. was appointed chief engineer. In this connection, he designed a complete line of electric traveling and special forge shop cranes, hoists, wire fence machinery, rolling mill equipment, etc.

In 1908, on consolidation of his company with Johnston & Jennings Co., of Cleveland, Mr. Carman became chief engineer and manager of the engineering and machinery departments of the new organization. At this time, he was also engaged by the Osborne Mfg. Co., of Cleveland, to design, manufacture and introduce a complete line of foundry molding machines, the design to be on sound engineering lines and the standard of manufacture equal to that of the machine tool industry



EDWIN S. CARMAN, OF CLEVELAND, O., PRESIDENT-ELECT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

In 1913, he became directly associated with the Osborne Mfg. Co. as chief engineer and in 1916 was elected a director and secretary of the company, and is now works manager of both machine and foundry brush divisions.

Mr. Carman has written a treatise on Foundry Molding Machines and Pattern Equipment as well as numerous papers on machine molding. He has served as president of the Cleveland Engineering Society, was first chairman of the Cleveland section A. S. M. E. and a member of the Committee on Aims and Organization. He served on the joint committee of the four chief engineering societies to formulate a plan for co-operative action. Subsequently he was a delegate for the A. S. M. E. to the Washington conference at which the organization of the Federated American Engineering Societies was decided upon.

He has served on the Committee on Constitution and By-Laws, was chairman of the Committee on Local Sections, and has taken an active part in affairs of the A. S. M. E. since his election to membership in 1917. Under his leadership, the society is certain to be well administered and to take active part in all progressive action for the advancement of engineering.

News Notes

THE ANNUAL meeting of the American Society of Mechanical Engineers will be held at the Engineering Societies Building, New York City, Dec. 7 to 10.

Besides papers on the general engineering subjects, there will be a session of the Fuel Section at which papers will be read on: Fuel Supply of the World, L. P. Breckenridge; Low-Temperature Distillation of Coal, O. P. Hood; Fuel Conservation: The Need for a Definite Policy and Its Requirements, D. M. Myers; Form Valve of Energy in Relation to Its Production, Transportation and Application, Chester G. Gilbert and Joseph E. Pogue.

This will take place Tuesday afternoon, the evening being devoted to the president's address and a reception. Wednesday morning will be given up to a business meeting and in the afternoon papers on research subjects will be presented as follows: Calibration of Nozzles for the Measurement of Air Flowing Into a Vacuum, W. L. de Baufre; The Heat-Insulating Properties of Cork and Lith Board, A. A. Potter, J. P. Calderwood, A. S. Mack and L. S. Hobbs; The Constitution and Properties of Boiler Tubes, A. E. White.

Wednesday afternoon an address on the life of Dr. John A. Brashear will be delivered by Dr. Henry Smith Pritchett of the Carnegie Foundation. Thursday morning will be given up to a number of papers on transportation and during the afternoon a session will be held covering the following subjects of interest to power plant men: Effect of Fittings on Flow of Fluids Through Pipe Lines, D. E. Foster; Steam Formulas, R. C. H. Heck.

Friday morning the Power Section will hold a session on "Future Power Development," the papers to be presented covering the subjects of: The Policy of Future Power Development; Effect of Load Factors on Cost; Effect of Size of Plant on Cost, and Financial and Legal Aspects of Future Power Development.

All engineers are welcome to technical session of the society and its sections. For the social events, those not members should be registered as guests of members.

THE ARRANGEMENT COMMITTEE of the Chicago Subordinate of the National Association of Practical Refrigerating Engineers, announces a change in dates of the national convention to be held in Chicago, at Hotel Sherman. The new dates are Dec. 13 to 16, inclusive, four days later than originally planned.

The National Association of Practical Refrigerating Engineers is showing great growth, and the Chicago convention is expected to be the greatest ever held by the association during its 11 yr. of existence. The program is entirely educational, and as arranged amounts, in fact, to a well organized intensive course of instruction. Men who are recognized leaders in their respective fields of endeavor in the refrigerating industry have been chosen to prepare the papers on the program.

The officers of the National Association and Chicago Subordinate extend a cordial invitation to all refrigerating engineers to attend the convention, whether members or not, and in this connection they say that the entertainment features, as well as the program, will be well worth while.

THE TAYLOR SOCIETY will hold its annual meeting in New York in the Engineering Societies Building, Dec. 2 to 4.

The evening of the 2d will be devoted to a general social gathering, Friday morning to various reports on "Scientific Management in the Sales Department," the afternoon to a discussion of these reports and the evening to a discussion of "The Long Day in the Steel Industry." Saturday morning will be given to papers on the "Standardization of Products," the afternoon to a discussion of this subject and the evening to an address on "Risk—A Retarding Factor in Production."

All sessions are open to the public.

THE NATIONAL RESEARCH COUNCIL has established a Research Information Service as a general clearing-house and informational bureau for scientific and industrial research. This "service" on request supplies information concerning research problems, progress, laboratories, equipment, methods, publications, personnel, funds, etc.

Ordinarily inquiries are answered without charge. When this is impossible because of unusual difficulty in securing information, the inquirer is notified and supplied with an estimate of cost.

Much of the information by this bureau is published promptly in the "Bulletin" or the "Reprint and Circular Series" of the National Research Council, but the purpose is to maintain complete up-to-date files in the general office of the Council.

Requests for information should be addressed, Research Information Service, National Research Council, 1701 Massachusetts Ave., Washington, D. C.

THE J. B. ENGINEERING SALES CO. have been appointed Connecticut sales agents of the Conveyors Corporation of America, formerly American Steam Conveyor Corporation. Offices are located at 60 Prospect St., Hartford, Conn.

MONARCH SOOT REMOVER CO., Inc., formerly of Troy, N. Y., has changed from a New York to a Massachusetts charter of incorporation and removed its plant to Wollaston, Mass. Offices will be at 261 Franklin St., Boston, Bradford L. Ames being president and Leonard W. Newell treasurer.

ANNOUNCEMENT has been made by the Westinghouse Electric & Manufacturing Co. that negotiations are being closed for the purchase of the plant and property of the Independent Lamp & Wire Co., located at Rochester, Pa. Although this plant was formerly used for the manufacture of glassware, the Westinghouse Co. plans to utilize it for the production of micarta materials of all kinds, as well as repair parts for electrical machinery. This plant has a total floor space of upwards of 130,000 sq. ft.

FAIRBANKS, MORSE & Co. has purchased the entire business consisting of all stock on hand, good-will and liabilities of the Luster Machine Shop & Railway Equipment Co., 917 Arch St., Philadelphia. Fairbanks-Morse has opened a new branch at this address under the management of D. W. Dunn. The entire personnel of the Luster Machinery Co. has been retained. E. J. Luster, former president, will be manager of the machine tool division of the Fairbanks-Morse Philadelphia branch.

ALBERT H. HOPKINS has resigned from the presidency of the Engineering Advertisers' Association of Chicago, and from the managership of advertising and sales promotion departments of the C. F. Pease Co., Chicago, to become Chicago manager of the J. Roland Kay Co. Mr. Hopkins is well known through the Middle West as a former publishers' special representative, and through his activities as an organizer and charter member of the above association. His work with the J. Roland Kay Co. will also be in the capacity of manager of its rapidly expanding domestic division.

ARTHUR E. HAUCK, president of the Hauck Mfg. Co., died at his home in Flatbush, Brooklyn, N. Y., Oct. 30, at the age of 41 yr. Beginning as a coppersmith in Germany, he followed his trade in Belgium, France and England, coming to the United States when 20 yr. old and entering Philadelphia Navy Yard where he worked 3 yr. He left to start in the oil burner business in 1902, and has developed his inventions until they occupy an important place in the using of kerosene for industrial and power purposes.

JOHN R. ALLEN, a leading engineer in heating and ventilation, died at his home in Pittsburgh, Oct. 26. Mr. Allen was born in Milwaukee 51 yr. ago. He graduated from the University of Michigan, then became an instructor there and later was advanced to a professorship in his chosen subject. From 1911 to 1913, he was dean of the engineering department of Robert College at Constantinople, returning to his work at Michigan, which he continued in connection with consulting practice until he accepted the position as director of the Research Bureau of the American Society of Heating and Ventilating Engineers, in Pittsburgh.

W. S. QUIGLEY, president Quigley Furnace Specialties Co., New York City, has just returned from Europe after an extensive trip made in connection with large installations of the Quigley powdered coal system in Italy and Belgium.

DAMAGE OF $10,000 was done to the power plant of the Unitile Co., Uhrichsville, O., by fire caused from sparks of a passing locomotive. The plant will be rebuilt.

Trade News

A 300-HP. TYPE "E" Smith anthracite coal gas producer will be installed in the power plant of the Huron Light & Power Co., Huron, S. Dak. This producer plant is to take care of the increased load demand formerly met by a producer also of the same type. The requirements to be met in this plant are for a uniform quality of thoroughly cleaned gas for indefinite periods.

THE WESTINGHOUSE Electric & Manufacturing Co. announces that its sales billed during the 6 mo. period from April 1 to Sept. 30, 1920, amounted to $78,771,675. The sales billed during the previous year ending March 31, 1920, totaled $136,052,092, so that the current year's business is in excess of last year's.

The earnings for the same period were as follows:

	Six Months, April 1—Sept. 30, 1920	Twelve Months Ending March 31, 1920
Gross income	$8,164,875	$16,801,164
Interest charges	751,852	1,594,823
Net income available for dividends, etc.	7,413,023	15,206,341

The current assets on Sept. 30, 1920, were $128,630,880, which compare with $101,896,951 for March 31, 1920, while the current liabilities were practically the same for the two dates, i.e., $31,000,000 in round figures.

The $30,000,000 issue of 7 per cent gold bonds recently put out by the company (subject to the favorable action of the stockholders at the meeting on Nov. 18) has all been sold.

MACRAE'S BLUE BOOK contains, arranged in alphabetical order, the names and addresses of 35,000 of America's leading manufacturers, showing, in many cases, location of branch offices. They are indexed under 14,000 classifications of material and supplies with an alphabetical index of trade names of materials and the names and addresses of the manufacturers thereof.

Miscellaneous data are given, such as weights, measures and tables, also a standard list price section, giving all standard list prices on commodities in common use and a net discount computer.

The book is 8 by 11 in., with 2000 pages, and weighs 11 lb.

THE PACKARD ELECTRIC Co., of Warren, Ohio, has issued a bulletin on "Metering Transformers" in which are described the weatherproof and switchboard types of the single, two and three-phase potential and current transformers. The weatherproof, or out-door type of oil-insulated transformer has been developed in compliance with the insistent demand from the central manager who is anxious to avoid the building of a housing to protect the transformers from the weather.

"NONPAREIL INSULATING BRICK," a 72-page illustrated book on the insulation of high temperature industrial equipment, such as boilers, furnaces, stills, hot blast stoves, ovens and kilns, is a recent publication of Armstrong Cork Co., Pittsburgh, Pa.

While dealing particularly with the description of Nonpareil brick and their uses, the book is more than a catalog. The subject of heat insulation has been thoroughly studied from both the theoretical and practical standpoints, and the results here compiled contribute to make this book a really valuable and instructive treatise. It is conveniently divided into sections, each dealing with a particular type of industrial apparatus. Operating records, with and without insulation, are given, savings demonstrated, and advantages to be secured by the use of Nonpareil brick.